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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

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19 AUGUST 1986

USSR REPORT

CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

CONTENTS

SOFTWARE

PROGRAM LIBRARY OF SM 1600 SPECIAL PROCESSOR

Moscow VESTNIK STATISTIKI in Russian No 2, Feb 86 pp 47-49

[Article by V. Popkova, engineer-designer, Vilnius Calculator Plant imeni V.I. Lenin]

[Text] The program library for the SM 1600 computer system special processor (the BSPR SM 1600) is a set of programs designed for the implementation of standard procedures for processing economic statistical data under control of the OS RV [Real-Time Operating System]. These include the input and primary processing of data, the sorting and merging of data, and the printing of reports. This library is used for the logical processing of alphanumeric data having heightened memory and processing time requirements (e.g., the sorting of large files of data, the control of processes requiring complicated computations with a high rate of the arrival of requirements), as well as in calculations of a scientific and technical nature.

The BSPR makes it possible to process data efficiently under control of the SM [System of Small Computers] computer Real-Time Operating System (version 2.1 and all subsequent versions) by utilizing a special processor of the M 5100 type. It offers the user the necessary facilities for programming a special processor by the facilities of the OS RV (macro assembler), and is also provided with generation facilities making it possible to construct working versions for specific modifications of the OS RV.

The programs implement the above-named procedures by means of both processors--the master (VP) and special-purpose (SP). Here the VP (a processor of the SM 4 type) performs functions implementing interfacing with the OS RV; and the SP (a processor of the M 5000 type) performs data processing, i.e., editing, recoding, various kinds of copying of variable-length fields, etc. This distribution of functions performed by the processors is due to the structure of the SM 1600 computer system: The VP controls the operation of the memory and all units, and the SP works only with the working storage (OP). Here the SP does not load the "common bus" (OSh) since it has a separate input to the OP. It is feasible to use BSPR programs in heavily loaded systems for the purpose of relieving the VP and improving the reactivity and total throughput of the system; an interpreter of the DIAMS language is effectively implemented in the SP.

Description of Program Library of Special Processor

The SP's programs were written by means of the OS RV macro assembler, which was expanded by a set of macro instructions implementing SP instructions. SP procedures in the source text are executed as subroutines. Accessing of them is indicated by the programmer by means of the ISR and RTS instructions or the CALL and RETURN macro instructions. The switching of calculation from the VP to SP is performed by a control subroutine which is attached to the task at the design stage. Calculation switching and processing of an interrupt from the SP occupy on average 10 VP instructions. Taking into account the difference in the speed of the processors (the SP is an order faster than the VP in performing decimal arithmetic and executing instructions for processing variable-length fields), it can be stated that in addition to relieving the VP and improving the system's reactivity, the employment of the SP enables higher throughput in the solution of individual problems.

The BSPR includes the following programs: control; SP programming facilities; for the input of data, sorting and merging; a report generator; and a program for the transfer of data files from the M 5100 DOS / SM 1600 DOS to the OS RV. They operate under control of the OS RV operating system version 2.1 and all subsequent versions and are considered normal working programs of the OS RV (besides the SP driver). While the BSPR is being used, the set of programs can be supplemented by programs written by the user.

The control programs are designed for switching calculation from the VP to the SP, for servicing an interrupt from the SP and for processing SP errors. The SP driver included in the control programs is written as loadable and therefore the inclusion of control programs in the OS RV can be performed at any time provided the loadable driver function was indicated in generation of the working OS RV.

The SP's programming facilities are designed for the implementation of task algorithms in SP codes. Essentially, they represent a set of macro instructions (a total of 74), each of which corresponds to a single SP instruction. The macro instruction format was made maximally close to the VP instruction format, which facilitates the programmer's working in "two instruction sets." In the OS RV operating system, SP macro instructions are organized either in the form of an individual library, the SSLIB.MLB, or in the OS RV macro assembler systems library, OCMAC.SML.

The data input program is designed for inputing of data with primary processing from the keyboard of a display. At the same time the data are checked and converted into serial disk files of the OS RV SUD [data management system]. Then they can be included in the FOBRIN data base. The control language by means of which the operator maintains communication with the data input program is a subset of the FOBRIN language. The data input program occupies 16K bytes in the working storage and loads the VP only slightly, since all processing of data is done in the SP.

The sorting and merging routines process a file of randomly arranged records, two ordered files or a set of records located in the working storage. During

the execution of these routines both the computing system's VP and SP are occupied. The VP basically executes operations for interchanging information with peripheral media and systems operations associated with the execution of segmented programs. All data manipulation operations are performed in the SP. Disk working files which are erased at the end of sorting are used in the process of sorting for the purpose of storing intermediate results.

The report program generator is designed for programming tasks which form reports with various formats. The printed-report programming language of the SM-computer COBOL system is used as the input language. As a result of compilation of the source program, the report program generator prepares an object module in the format of the OS RV task designer. At the stage of designing the task, this object module can be united with other modules of the same kind made into a single task by FORTRAN or COBOL compilers. Accessing of the module in the source language is executed via the CALL statement. Tasks designed by means of the report program generator load the VP only slightly, since the processing of data is performed only in the SP. The report program generator itself is designed by using only the VP.

Programs for the transfer of data files from the M 5100 DOS / SM 1600 DOS to the OS RV are designed for facilitating the change from the data processing method used in the M 5000 series computers to the method based on the use of SM-computer standard operating systems, in this case, the OS RV. As the result of the execution of transfer programs on disks in the OS RV format, serial files of the OS RV SUD system are formed which can be included in the FOBRIN data base.

On the basis of what has been said, it is possible to define more precisely the applicability of the SP. As optimal areas of application it is necessary to indicate the programming of algorithms for the processing of complex logic-arithmetic expressions, syntactical analysis and computations employing decimal arithmetic. For example, an interpreter of the DIAMS language is implemented effectively in the SP.

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ON INTEGRATED QUALITY INDEX OF SOFTWARE FOR ASU

Moscow STANDARTY I KACHESTVO in Russian No 3, Mar 86, pp 58-59

[Article by A.P. Nudelman, NPO [scientific industrial association] "Progress"]

[Text] The industrial character of writing software (PS) for automated management systems [ASU], as well as the dependence of the results of managing the national economy on software reliability and quality, lead to the fact that software is considered now to be one of the most important types of industrial products.

Works devoted to problems of assessing the quality of programs usually offer a nomenclature of PS quality indeces and methods for measuring thereof [1, 2]. General concepts of the theory of software quality assessment have been developed by a well known Soviet scientist V.V. Lipayev [3], who points out to the analogy between software qualimetry and qualimetry of other types of products. The quality level of the majority of product types can be most comprehensively expressed by an integrated index that characterizes both functional properties and economic efficiency of products [4]:

$$K_\Sigma = \frac{\Pi_\Sigma}{З_с + З_п},$$

where Π_Σ is an aggregate useful effect from product's use; $З_с$, $З_п$ are respectively the cost of manufacturing and consuming a product.

For ASU PS, the above costs correspond to the development cost ($З_р$) which can be determined precisely, and follow-up ($З_с$) and modernization ($З_м$) costs which can be forecasted based on data on industrial operation over a long period.

The determination of the aggregate useful effect of using software that is regarded an indispensable part of the ASU problem it insures the functioning of, is very difficult, because it is practically reduced to formalizing the improvement of the results of managing an object. Calculations of economic efficiency of functioning of ASU problems are basically approximate, and its expansion into components of the problem (software, hardware and data base organization and support) is practically impossible.

In our opinion, it is permissible to separate the useful effect of PS

application in connection with its role in the ASU problem functioning. This role is to reduce the degree of uncertainty of information about an object, as a result of regular processing of a certain volume of data.

It is obvious, that for problems of economic data processing the reduction of the degree of uncertainty of information about an object is proportional to the volume of processed data, and therefore the useful effect over the entire period of industrial operation of the software can be expressed by the aggregate volume of processed data:

$$V_{\Sigma} = N \sum_{i=1}^{n} (V_{\text{Bx}} + V_{\text{HCH}} + V_{\text{n}})$$

where $V_{\text{nx}}, V_{\text{HCH}} + V_{\text{n}}$ are respectively mean volumes of input, reference and conditionally-permanent data files that are processed during usual operation of the software, byte; n is the number of data processings per year; N is the number of years of PS operation.

Then the expression for the integrated ASU PS quality index has the following form:

$$K_{\Sigma\,\text{nc}} = \frac{V_{\Sigma}}{3_{\text{p}} + 3_{\text{c}} + 3_{\text{M}}}\,.$$

In order to test the efficiency of using the suggested form of the integrated ASU PS quality index, studies were conducted of software for subsystems and individual problems of the industry automated management system (OASU) of the Latvian SSR Ministry of Local Industry.

Representativity of the formed sample of studied ASU PS and objectivity of the results and conclusions of the conducted comparative analysis are insured by a number of factors. For instance, by the presence in the sample of software that supports elements of ASU of all clases: developed specifically for the above mentioned OASU, purchased from other organizations and adapted to the OASU. Due to the fact that certain OASU elements were redeveloped in the 11th five-year plan period because of a significant change in needs for result-oriented information, both versions of software of these elements, correspondingly designed at various programming levels, were included in the sample in pairs. Acquisition and processing of initial data used for technical and economic indeces of ASU PS had been conducted during a long enough period (not less than three years). The overall volume of the formed sample was comprised by 23 pieces of studied software, that included 549 programs developed in two basic types of problem-oriented programming languages for data processing problems (PL-1 and COBOL) and in languages of specialized batches of applied programs (PPP) and of the database management system.

The complexity of processes of development and operation of ASU PS, as well as a large number of factors affecting these processes (computer completeness,

employed methods for PS development and operation, customer's requirements, qualifications of developers and those operating the PS etc.) cause the spread in and a random character of technical and economic indeces of PS development and operation. Due to this fact, methods of mathematical statistics were used in the study.

To determine technical and economic indeces of the development and operation of the studied PS sample, the retrospective method of statistical processing [3] of organizational-administrative, target, reporting and procedural documents of operational activity of OVTs [industry computer center] of Latvian SSR Ministry of Local Industry for the 1979-1985 period was used in this study. The values of technical and economic indeces of ASU PS were determined in accordance with recommendations given in [3, 5].

To check the interrelationship between the integrated quality index and the technical and economic indeces of ASU PS, correlation analysis of the derived series of values was performed.

Examples of the results of these studies are presented in the table.

Integrated Quality Index and Technical and Economic Indeces of ASU PS

	(1) Наименование ПС АСУ, год разработки (2)	Значение интегрального показателя качества, байт/руб. (12)	Удельные затраты разработки одной строки исходного текста программ, руб./строка (13)	Удельные затраты внедрения одной строки исходного текста программ, руб./строка (14)	(15) Удельные годовые затраты сопровождения одной строки исходного текста программ, руб./строка	(16) Стоимость обработки одного байта информации, откорректированная на сложность алгоритма обработки, в промышленной эксплуатации, руб./байт
	Оперативное управление, 1975 г. (3)	710,89	7,14	0,639	0,933	$0{,}094\cdot10^{-3}$
	Оперативное управление, 1984 г. (4)	984,29	3,79	0,862	0,175	$0{,}069\cdot10^{-3}$
(4)	Расчет планов производства предприятий, 1975 г.	861,51	5,45	0,729	0,323	$0{,}128\cdot10^{-3}$
	Расчет планов производства предприятий, 1984 г. (5)	1897,90	3,80	1,166	0,188	$0{,}063\cdot10^{-3}$
(6)	Анализ результатов соцсоревнования, 1976 г.	1235,97	4,61	0,403	0,059	$0{,}153\cdot10^{-3}$
	Анализ результатов соцсоревнования, 1983 г. (7)	3911,07	3,56	0,392	0,181	$0{,}060\cdot10^{-3}$
(8)	Труд и зарплата, 1975 г.	645,70	5,27	0,263	0,281	$0{,}085\cdot10^{-3}$
	Труд и зарплата, 1983 г. (9)	1284,81	2,15	1,286	0,047	$0{,}058\cdot10^{-3}$
(10)	Расчет и анализ рентабельности изделий, 1975 г.	1087,48	4,04	0,901	0,271	$0{,}123\cdot10^{-3}$
(11)	Расчет и анализ рентабельности изделий, 1985 г.	1717,50	2,55	0,932	0,137	$0{,}102\cdot10^{-3}$

Key:

1. ASU PS title and year of development
2. On-line control, 1975
3. On-line control, 1984
4. Calculation of production plans of enterprises, 1975
5. Calculation of production plans of enterprises, 1984
6. Analysis of the results of socialist competition, 1976
7. Analysis of the results of socialist competition, 1983
8. Labor and payroll, 1975
9. Labor and payroll, 1983
10. Calculation and analysis of products' profitability, 1975
11. Calculation and analysis of products' profitability, 1985

(Key continued on following page)

12. Integrated quality index value, byte/R
13. Specific cost of developing a line of the initial program text, R/line
14. Specific cost of implementing a line of the initial program text, R/line
15. Specific annual cost of following up a line of the initial program text, R/line
16. Cost of processing a byte of information, adjusted for the complexity of the processing algorithm, in industrial operation, R/byte

We shall only present the main conclusions derived from the conducted studies:

the presence of a medium inverse correlation (R_k=-0.458) between the integrated quality index and the specific cost of PS follow-up has been established;

the presense of a strong inverse correlation (R_k=-0.882) between the integrated quality index and the specific cost of processing a byte of information, adjusted for the complexity of the data processing algorithm, in industrial operation has been established;

the suggested integrated index is a representative characteristic of functional effectiveness and economic efficiency of PS and can be used as the most general quality estimate in comparing software for similar applications.

BIBLIOGRAPHY

1. Bohem, B., Brown, J., Kasper, H., Lipov, M., McLeod, G. and Merit, M., "Kharakteristiki kachestva programmnogo obespecheniya" [Software Quality Characteristics], Moscow, "Mir", 1981.

2. Nudelman, A.P., "Nomenclature of Indeces of Scientific and Technical Level of Software for ASU", STANDARTY I KACHESTVO, 1984, No 2.

3. Lipayev, V.V., "Kachestvo programmnogo obespecheniya" [Software Quality], Moscow, "Finansy i statistika", 1983.

4. "Metodika otsenki urovnya kachestva promyshlennoy produktsii" [Procedure for Assessing Quality of Industrial Products], Moscow, Izdatelstvo standartov, 1971.

5. Lipayev, V.V., Makarov, V.I. and Potapov, A.I., "Calculation and Analysis of Technical and Economic Indeces of Software Development", USiM, 1982, No 1.

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INTERVAL NORMS FOR INPUT OF MACHINE TIME WHEN USING SYSTEMS ELECTRONIC DATA PROCESSING COMPLEXES

Moscow VESTNIK STATISTIKI in Russian No 2, Feb 86 pp 42-47

[Article by V. Fedoseyev, senior scientific associate, NII TsSU SSSR [Scientific Research Institute of the USSR Central Statistical Administration]]

[Text] As we know, at the present time about 60 systems KEOI's [electronic data processing complexes] are in constant use in the computer network of the USSR TsSU [Central Statistical Administration], and fees for the machine time put in in the process constitute one of the main items of total expenditures for the electronic processing of statistical information. Therefore, improvement of the set of norms for the input of machine time when employing systems KEOI's is of great importance for the purpose of improving the efficiency of the ASGS [Automated System for State Statistics] as a whole.

Numerous observations of the process of the utilization of KEOI's at computer centers of the USSR TsSU system, in particular, work done at the RSFSR TsSU's Rosglavmashinform [not further identified], have demonstrated that for each systems KEOI the dependence of the actual input of machine time, T, on the amount of information processed, N, can be expressed by means of an empirical curve, $T = T(N)$, the characteristic features of which are monotonicity of the increase in the value of T with an increase in the amount of information, N; the presence of a certain initial jump, $T_0 = T(0)$; and a gradual reduction in the slope of this curve with reference to the amount-of-information axis.

For many systems KEOI's the reduction in the slope of the $T = T(N)$ curve in actually existing ranges of amounts of information processed is insignificant; therefore, for each specific model of YeS [Unified Series] computer this curve can be reduced to a straight line of the type

$$T = T_0 + T_N \cdot N . \qquad (1)$$

In equation (1), N represesents the number of calculation units for the amount of information (hundreds of reports, thousands of lines, etc.) used for a given KEOI. The aggregated normative indexes, T_0 and T_N, are calculated by the formulas:

$$T_0 = T_{1\ baz} + T_{3\ baz} \cdot K_{EVM},$$

$$T = T_{2\ baz} + T_{4\ baz} \cdot K_{EVM},$$

where K_{EVM} represents the experimentally established productivity (speed) coefficient of the computer in solving statistical procedure problems. The base normative indexes, $T_{1\ baz}$, $T_{2\ baz}$, $T_{3\ baz}$ and $T_{4\ baz}$, are determined by aggregating step-by-step norms within the limits of each of the four groups into which the steps of the production process of using KEOI's are divided, for the degree of the dependence of the input of machine time on the factors of the amount of information to be processed and the speed of the computer. In the first group, neither the first nor the second factors are essential; in the second, the first factor is nonessential and the second is essential; in the third, the first is essential and the second is nonessential; and in the fourth, both factors are essential. The expression of the dependence of the input of machine time on the amount of information in the form of linear function (1), validated for many systems KEOI's, makes it possible to express the set of norms for the input of machine time for each such KEOI and specific model of YeS computer in terms of two aggregated normative indexes--T_0 and T_N. A fragment of a table of these indexes which can be recommended for calculating normative (planned) input of machine time at the level of an oblast and Union republic without division into oblasts is presented in table 1.

Table 1. Aggregated Normative Indexes for Input of Machine Time When Using Systems KEOI's for Oblasts and Union Republics Without Division into Oblasts

Abbreviated name of KEOI	Calculation unit for amount of information	Aggregated normative indexes, machine-hours							
		YeS-1022 YeS-1030 (K_{EVM} = 1.0)		YeS-1022 with disk storage YeS-5056 (K_{EVM} = 1.2)		YeS-1033 YeS-1035 (K_{EVM} = 0.9)		YeS-1040 YeS-1045 (K_{EVM} = 0.8)	
		T_0	T_N	T_0	T_N	T_0	T_N	T_0	T_N
Form No 1-t (quarterly)	100 records								
For quarters I, II and IV		5.5	3.3	5.7	3.7	5.4	3.1	5.3	2.9
For quarter III		7.5	3.3	7.7	3.7	7.4	3.1	7.3	2.9
Form No 1-t (annual)	"	4.0	8.1	4.0	9.1	4.0	7.6	4.0	7.1
Form No 8-nt	100 lines	11.5	2.3	11.9	2.5	11.3	2.2	11.1	2.1

However, as demonstrated by practical experience, for a number of systems KEOI's the slope of the actual $T = T(N)$ curve with reference to the amount-of-information axis is reduced rather insignificantly with an increase in this amount. As a rule, this feature relates to those complexes of which is characteristic a large variance in the number of reports (lines) processed at

individual computer centers of the USSR TsSU system. These are, in particular, KEOI's for forms No 22, 11, 3-t (short, quarterly, annual), 1-mekh, 19, 2-nk, 3-nk, 5-nk, etc. This particular feature of the dependence of the actual input of machine time on the amount of information processed for these KEOI's does not make it possible to reduce it to a single linear function of type (1), since in this case computer centers (RVTs's [republic computer centers]) which process a number of reports greater than the average would prove to be in a more advantageous position from the viewpoint of observing the norms set than the remaining computer centers, i.e., the norms will be too high for them.

In these cases it is necessary to divide the entire range of the number of reports to be processed into a number of intervals and to establish so-called "interval coefficients" (K_{int}) for each of them. If it is assumed that $K_{int} = 1.0$ for the base, i.e., the first interval in order, then for all subsequent intervals the values of this coefficient will diminish in accordance with a reduction in the slope of curve $T = T(N)$ with reference to the amount-of-information axis. The specific values of interval coefficients can be established on the basis of an analysis of actual data on the input of machine time at indivdual stages of the production process in the utilization of KEOI's.

Let us discuss the step-by-step norms used in the RSFSR TsSU's computer network for KEOI's for form No 3-t (short); these norms for the YeS-1022 computer are presented in table 2.

Table 2. Norms for Input of Machine Time for Processing Statistical Paperwork on Basis of KEOI for Form No 3-t (Short)

No	Production process steps	Calculation unit for amount of information	Base input norm, machine-hours
1	Setup of media	Total	1.0
2	Handling of catalogue and manuals	100 reports	0.3
3	Input, check and writing of initial information	Ditto	1.8
4	Correction of initial information	"	0.9
5	Formation of reports	"	0.7
6	Correction of reports	Total	1.0
7	Printing of output tables	Ditto	1.5
8	Duplication of tapes for higher level	"	1.0
9	Processing of materials for local-authority agencies	100 reports	0.5

Note: Norms for items 2, 3, 4 and 5 must be used with a factor of 1.0 for each next number of reports in the interval of up to 100 reports, with a factor of 0.7 from 100 to 200, with a factor of 0.5 from 200 to 400, and with a factor of 0.2 for over 400.

As follows from table 2 and the note to it, the input of machine time not depending on the amount of information equals 4.5 machine-hours, and 0.5 machine-hours per each 100 primary reports with a constant proportionality factor of 1.0, and 3.7 machine-hours with the following interval coefficients taken into account: 1.0 for up to 100 reports, 0.7 for 100 to 200, 0.5 from 200 to 400 and 0.2 for over 400 reports. Then generalized interval coefficients are calculated for each interval as weighted mean values, where the weights will be the normative input of machine time in individual intervals of the amount of information and steps of the production process for a given KEOI. For example, for the interval of "from 200 to 400 reports" the generalized interval coefficient for a KEOI for form No 3-t (short) will be:

$$K_{int} = (4.5 + 0.5 \cdot 2 + 3.7 \cdot 2 \cdot 0.5) : (4.5 + 0.5 \cdot 2 + 3.7 \cdot 2) = 0.7 .$$

Thus, the following values of generalized interval coefficients have been established for processing primary reports for form No 3-t (short):

$K_{int} = 1.0$ (for interval of up to 100 reports);

$K_{int} = 0.9$ (100 to 200);

$K_{int} = 0.7$ (200 to 400);

$K_{int} = 0.45$ (over 400 reports).

These coefficients can be calculated similarly for other systems KEOI's.

Let us discuss how aggregated normative indexes for input of machine time are calculated with the assignment of intervals for the amount of information processed and by taking into account the respective interval coefficients. Let us assume that for a certain systems KEOI the entire real range of the number of reports processed at individual computer centers of the USSR TsSU system is divided into three intervals; here in the first (base), "up to N_1 calculation units of the amount of information," $K_{int} = 1.0$. The aggregated normative indexes, T_{01} and T_{N_1} , for a specific model of a YeS computer are calculated in this interval similarly to those KEOI's in which intervals for the amount of information are not assigned (they are considered known). Let us assume also that in the interval "from N_1 to N_2 " the interval coefficient has a value of K_{int2} , and in the interval "over N_2 " it equals K_{int3} $(K_{int3} < K_{int2} < K_{int1} = 1.0)$. Then, for the second interval, "from N_1 to N_2 ," the value of aggregated normative index T_{N_2} , defining in accordance with (1) the slope of the $T = T(N)$ curve, is computed by the formula: $T_{N_2} = T_{N_T} \cdot K_{int2}$. The corresponding value of normative index T_{02} is determined from the condition that for one and the same amount of information, N_1 , machine time input values calculated according to equation (1) must agree for two pairs of values of aggregated normative indexes, (T_{01}, T_{N_1}) and (T_{02}, T_{N_2}) . As a result, the following formula will be valid for the value of T_{02} : $T_{02} = T_{01} + (T_{N_1} - T_{N_2}) \cdot N_1$.

Similarly, the aggregated normative indexes of machine time input for the third interval, "over N_2," must be calculated by the formulas:
$T_{N_3} = T_{N_1} \cdot K_{int3}$ and $T_{03} = T_{02} + (T_{N_2} - T_{N_3}) \cdot N_2$.

Thus, in general form, for a certain j-th interval of the range of amounts of information to be processed (j = 2, 3, ...), the following recursion formulas are valid for calculating interval aggregated normative indexes for input of machine time:

$$T_{N_j} = T_{N_1} \cdot K_{int\ j};$$
$$T_{0_j} = T_{0_{j-1}} + (T_{N_{j-1}} - T_{N_j}) \cdot N_{j-1}. \qquad (2)$$

With this approach, the normative (planned) input of machine time for the single processing of reports for each of the systems KEOI's discussed utilizing a specific model of a YeS computer is calculated by linear formula (1), whereby for computer centers with amounts of information processed of up to N_1 the aggregated normative indexes will equal T_{01} and T_{N_1}, with an amount of N_1 to N_2, T_{02} and T_{N_2}, etc. A normative straight line in coordinate plane (T, N) corresponds to each pair of these indexes, (T_{0j}, T_{Nj}), so that the T = T(N) curve for the actual input of machine time for each KEOI considered will be the envelope of a family of normative straight lines (cf. fig 1).

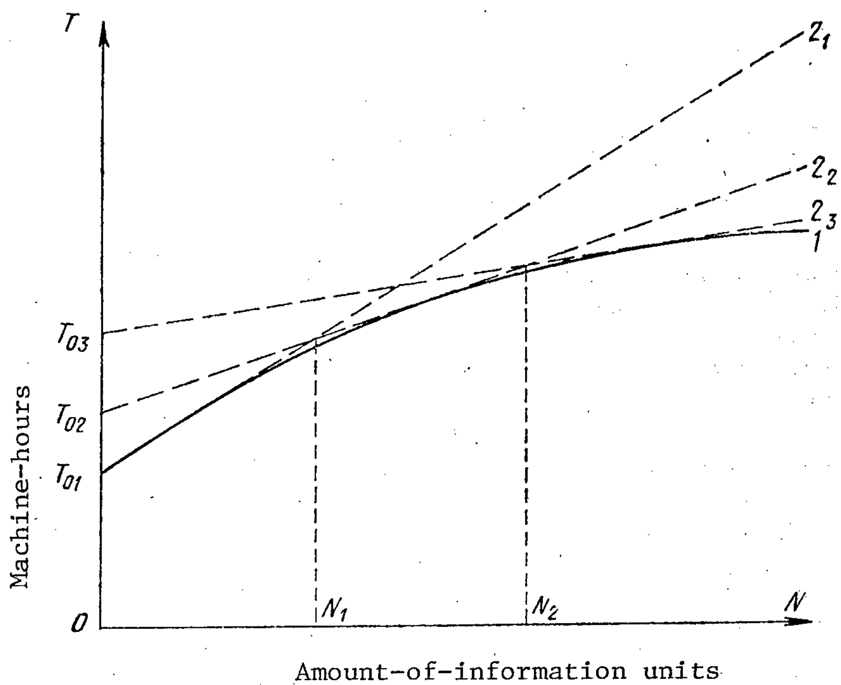

Figure 1.

The results of the calculation of interval aggregated normative indexes by recursion formulas (2) for the systems KEOI discussed for form No 3-t (short) and for a YeS-1022 computer are presented in table 3, in which 100 reports is used as the calculation unit for the amount of information.

Table 3. Interval Aggregated Normative Indexes for Calculation of Input of Machine Time for Systems KEOI for Form No 3-t (Short) at Level of Oblast and Union Republic without Division into Oblasts

Intervals for amount of information processed (reports)	Interval coefficient (K_{int})	Aggregated normative indexes, machine-hours	
		T_0	T_N
To 100	1.0	4.5	4.2
100 to 200	0.9	4.9	3.8
200 to 400	0.7	6.7	2.9
Over 400	0.45	10.7	0.9

As an example, let us present the calculation of planned (normative) input of machine time for a YeS-1022 computer for processing 390 reports for form No 3-t (short).

We find from table 3 that for this case $T_0 = 6.7$ machine-hours and $T_N =$ 2.9 machine-hours . Then the normative input of machine time for single processing of these reports is calculated by formula (1) and equals $T = 6.7 + 2.9 \cdot 3.9 = 18.0$ machine-hours , and the yearly input (for eight processings) will equal 144.0 machine-hours.

A unified table of interval aggregated normative indexes (cf. table 4) was developed on the basis of the step-by-step production process norms used in 1985 in the RSFSR TsSU computer network, utilizing the above-described method of calculating generalized interval coefficients and the recursion formulas, (2), derived for all systems KEOI's in which it is necessary to assign intervals for the amount of information to be processed.

It should be indicated that the method suggested for introducing generalized interval coefficients can be used in refining norms for input of machine time in those systems KEOI's for which intervals for the amount of information have not been assigned at the present time. Herein resides an important potential for a validated (plannable) reduction in the cost of the electronic processing of statistical information. In addition, the approach described in this article can prove to be useful in the development of a normative base for certain other production-process-organization forms for the automated solution of statistical problems, as well as for the refinement of production process parameters in a comparative evaluation of various kinds of ASGS systems software.

Let us note in conclusion that the implementation of such suggested methods as the aggregation of step-by-step production process norms for the input of machine time when using KEOI's by isolation of the above-indicated four groups of steps, the input of experimentally determined coefficients for the

productivity of various models of computers used (K_{EVM}), and taking into account the interval coefficients (K_{int}) introduced in this article for those KEOI's for which this is necessary, make it possible to solve as a whole the problem of the development of a unified, compact and convenient-to-use set of validated norms for the input of machine time for systems KEOI's. The practical application of this set of norms, as well as the improvement of it on the basis of regular statistical observation of the process of the utilization of KEOI's in the USSR TsSU computer network, the examination of new types and models of computers, including minicomputers, and taking into account the procedure used at the present time for calculating the amount of machine time realizable with the multiprogram mode of using computers, will make it possible to increase the effectiveness of the use of modern computer technology in solving problems of State statistical agencies.

Table 4. Interval Aggregated Normative Indexes for Input of Machine Time When Using Systems KEOI's for Oblasts and Union Republics Without Division into Oblasts

Abbreviated designation of KEOI; intervals for amount of information processed (reports)	Calculation unit for amount of information	Interval coefficient (K_{int})	Aggregated normative indexes, machine-hours							
			YeS-1022 YeS-1030 (K_{EVM} = 1.0)		YeS-1022 with disk storage YeS-5056 (K_{EVM} = 1.2)		YeS-1033 YeS-1035 (K_{EVM} = 0.9)		YeS-1040 YeS-1045 (K_{EVM} = 0.8)	
			T_0	T_N	T_0	T_N	T_0	T_N	T_0	T_N
Form No 22	100 reports									
To 200		1.0	4.0	6.9	4.0	7.7	4.0	6.5	4.0	6.1
200-500		0.9	5.4	6.2	5.6	6.9	5.4	5.8	5.2	5.5
500-1000		0.7	12.4	4.8	13.1	5.4	11.9	4.5	11.2	4.3
Over 1000		0.6	19.4	4.1	21.1	4.6	17.9	3.9	17.2	3.7
Form No 11	"									
To 100		1.0	2.0	6.4	2.0	7.1	2.0	6.1	2.0	5.7
100-200		0.9	2.6	5.8	2.7	6.4	2.6	5.5	2.6	5.1
200-400		0.8	4.0	5.1	4.1	5.7	3.8	4.9	3.6	4.6
Over 400		0.7	6.4	4.5	6.9	5.0	6.2	4.3	6.0	4.0
Form No 9-sn	10 reports									
To 80		1.0	4.5	0.65	4.7	0.7	4.4	0.6	4.3	0.55
Over 80		0.7	6.1	0.45	6.3	0.5	6.0	0.4	5.5	0.4

8831
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PROGRAM COMPLEX FOR EXPRESS-ANALYSIS OF THE DYNAMICS OF ECONOMIC INDICATORS

Moscow VESTNIK STATISTIKI in Russian No 3, Mar 86 pp 45-51

[Article by Engineering Candidate Yu. Dratskiy, Senior Engineer and Programmer A. Bakarayeva, Engineer M. Grobova, Chief Engineer of the Volgovyatglavsnab [expansion unknown] Computer Center, A. Tsedilenkov. "Program Complex for Express Analysis of the Dynamics of Economic Indicators" under the rubric "Mechanization of Accounting-Statistical Work"]

[Text] Economic units (cities, rayons, enterprises) must analyze a large number of technical-economic indicators (TEP) in order to improve justification of economic and social plans. This requires operational analysis of retrospective statistical data and multivariant forecasting of interconnected TEPs.

The KPD [efficiency] of forecasting is adversely affected by the lack of access on the part of local statistical organs to a mechanism for express analysis which is relatively uncomplicated on the level of statement and program realization.

The existing package of applications programs for mathematical statistics (ppp MS) is designed for the "Minsk-32" computer. The program packages which include mathematical statistics sections, for example PNP PL/1, are designed for processing the results of scientific experiments. Adaptation of these program packages to forecasting the development of separate industries under city administration would be very expensive. Therefore, we have developed an algorithm for express analysis and forecasting of the development of economic units. In developing the algorithm, we took into consideration statistical methods which are applicable to economic analysis. The program set was realized within necessary limits imposed by the technical specification of analyzing and forecasting a large number of dynamic TEP series.

The structure of the algorithm allows unlimited growth and expansion with new specification and program moduli.

Analysis of the dynamics of behavior of economic indicators requires automation of the following. First, determination of development tendencies for initial dynamic series (IDR) of absolute levels and production dynamic series (PDR): the rate of growth, increase, average sliding smoothed

increases, etc. Then, obtaining the PDR from the IDR and calculation of dynamic series of correlated indicators (coefficients of linear and rank correlation, partial correlation of ranks, variations, etc.). And finally, calculation of parameters of dynamic series (average geometric growth rate, average cumulative increase rate, etc.), and output of documents in the form of graphs, tables and guides.

The content and structure of the problem complex is presented in the form of an enlarged functional flow chart of control problems with separation of basic functions of data processing (Fig. 1 [not reproduced]).

In mathematical statistics there are many methods which measure trends with varying degrees of accuracy. Other possibilities are smoothing by aggregation of intervals, with the method of sliding averages, equalization with analytical formulas and others. These methods vary in complexity of application and clarity of measured trends. The problem is how to select the simplest from the number of smoothing methods and to carry it out so that the trend obtained will be sufficiently close to the real conditions described by the dynamic series under analysis.

In analysis of dynamic TEP series, one of the most widely used smoothing methods is that of equalizing with the analytic formula of the straight line $y_t=a_0ta,t$ with the method of least squares, which is rather simple; a trend is found without reducing the number of levels of the series. The final result of the analysis in this instance is evident and accessible to the user.

These considerations foretold the expedience of finding a linear trend at the first stage of analysis--rapid analysis of dynamic series. Further development of the complex will include the use of software for selecting appropriate methods for smoothing and finding trends which more accurately and more fully characterize the tendencies of the series under analysis. The mechanism which is developed for calculation and plotting of the ordinate of the linear trend may be used in analogous operations for representation of curved line trends.

Using methods of rank mathematics a universal scale was constructed on the ordinal axis, marked out by the ranks allocated to the absolute values of the variables. A certain inaccuracy which arises is not important in express-analysis of development tendencies. The documents printed in the form of graphs with a "rank-time period" system of coordinates fix the ordinates of TEP and/or trend levels being analyzed or forecasted. Ordinal points are denoted by letters for TEP levels and by digits for trend levels. Point coincidences of dynamic series of various TEPs and/or their trends are given below the abscissa axis.

The higher the absolute value of the variable, the lower the absolute magnitude of the rank assigned to levels of the dynamic series by the algorithm. This, along with absolute rank quantity increasing along the ordinal axis toward the coordinate origin, makes the arrangement of the trend lines on the graph natural. In this instance for TEP, the normal behavior of which, as a rule,

is characterized by increasing level values (production output, growth in labor productivity, quality control, etc.), a trend line which ascends at an angle (α), when $\sigma < \alpha < 90°$, with the ordinal axis is considered positive. For a TEP, the normal behavior of which is characterized by falling values for levels (the number of absences, defective goods, labor turnover, etc.), a trend line which descends at an angle (α), when $90° < \alpha < 180°$, with the ordinal axis is considered positive.

The arrangement of trend lines on the graph corresponds to magnitudes of their quantitative values--to coefficients of rank correlation (ρ) for the TEPs under analysis. Likewise, the quantitative values characterize the quality of development dynamics of a TEP or the dynamic state of an economic unit. These values may be used in ranking economic units using one or several TEPs in comparison with a given normative value.

In figure 2 [not reproduced], the connection between coefficients of rank correlation and tendencies of behavior of two TEPs is illustrated: labor productivity of production personnel (PPP) (Pf) and average salary of ppp (3f) in three enterprises ("Irina", Lyudmila" and "Nina"). To the right of the graph is a scale of values for ρ, which measure each trend; arrows indicate the trend for each enterprise.

The coefficient of rank correlation is determined in comparison with an ideal rank series of even growth (tendency II in fig. 2). Thus, in calculation of ρ for Pf "Irina," the following rank series are used:

T	181	281	381	481	182	282	382
Rank of II	10	9	8	7	6	5	4
Rank of Pf "Irina"	1	6	8	2	4	7	9

(continued)	482	183	283
Rank of II	3	2	1
Rank of Pf "irina"	5	1	3

The realized part of the program complex allows workers in planning and statistical organs, economists and directors of statistical administration of oblasts and control apparatuses of subdivisions of ispolkoms [executive committees] of local Soviet Peoples' Deputies to obtain with computers the results of analysis of development dynamics for any number of indicators.

This part of the program complex--express analysis of dynamic series (EKANDR)--includes 13 program moduli, written in PL/1 for OS YeS [Unified Computer System Operating System].

MOD - control program. Organizes data input, checking and processing, carries out dialogue with the computer operator over the course of analysis.

SINT - control of input data.

RANGI - ranking of TEP levels.

KVADRAT - smoothing by the method of least squares.

FORM - formation of single arrays with the number of elements determined by the TEP quantity and the number of trends put out on one sheet.

SORTB - sorting of arrays.

STRDIAP - formation of range of time periods for tilting output forms.

TABLIZA - formation and printing of output in the form of a table.

GRAFIK - formation and printing of output in the form of a graph (further abbreviated "grafik").

STRPRZN - formation of the abscissa axis for a graph with given flag for a time period.

STRINF - formation of informational lines of a graph.

SJATIE - obtaining an "array of coincidences" (equal values of ordinates of various TEPs in the fixed time period of the given range).

FSTROKA - obtaining an array of TEP ordinate values for output of a concrete graph line.

The complex is further expanded in block, 5, 9, 11, 12 (see fig. 1).

It has been proven in practice that determining and applying ordinates of trends and absolute levels in graphical and tabular form for three TEPs when the length of the dynamic series is 20 time periods requires about 1 minute on the YeS-1022 computer.

The tendency of a group of light production urban enterprises is determined by levels of basic TEPs (labor productivity, number and average salary of production personnel).

In figure 3 [not reproduced], the output document is shown in the form of a graph, which describes the behavior of three TEPs of the "Irina" enterprise. The ordinal points of TEP absolute levels and/or trends are plotted and printed. By combining these points, the user obtains a graphic interpretation of the TEPs being compared. Point coincidence is indicated below the abscissa axis. For example, "AB" indicates that the absolute level points identified by "A" and "B" coincide in the third section for 1981 (381). From the graph it is apparent that for ten sections of the current five-year plan, the average monthly salary (2) grows more quickly than labor productivity (1); the situation is very unfavorable. The number of production personnel (3) decreases; this is a positive tendency.

In fig. 4 [not reproduced] the output document-graph illustrates the tendencies of growth in labor productivity in three enterprises. The user may select trends only, without absolute levels, and any time period (day, 10-day,

month, quarter, year, five years). The graph may also be accompanied by a table (see table).

Express analysis of planned levels for contracted commodity production has revealed declining average-smoothed growth tendencies in the quarterly plans of several enterprises for three years of the eleventh five-year plan. Such an approach is especially important for analyzing the activity of enterprises engaged in economic experimentation. The magnitude of increase in certain indicators in comparison with the preceding period is considered the main measure of quality and work efficiency. Finding trends which have quantitative values according to basic TEPs for a large number of enterprises facilitates analysis of the strength of plans in the preceding period and evaluation of their projection onto future periods. In addition, the connection between planned and attained growth can be found and analyzed with a limited number of indicators by expanding the capacities of machine express analysis of the economic dynamics of the activity of economic units.

Experimental work in the use of a program complex for analysis of construction labor plan fulfillment (form No. 3-t-quarter) is now being carried out. This may result not only in illumination of tendencies, but also in ranking of construction trusts with integral criteria using basic indicators of economic activity.

By using an integral criterion which encompasses two types of correlation coefficient, it is possible to determine the degree of proximity of normative (specified by the dynamic normative) and comparative series.

The program complex "EKANDR" was designed as a partial solution to carry out the labor intensive calculation and graphing required for analysis of dynamic series of a great number of TEPs quickly. Therefore, economic efficiency was calculated by sector. However, an algorithm has been developed for the problem set which will allow maximal automation of a number of statistical methods and calculation of economic parameters which are significant for the work of economists, statisticians and planners in local statistical and Soviet organs.

We believe that this research and design work along with practical testing will significantly accelerate the creation of a compact, easily implemented, problem-oriented program complex for express analysis of economic indicators.

This package of applications programs will undoubtedly be widely applied in collective-use computer centers to serve the largest subscribers: rayon state statistics inspectors and subdivisions of executive committees of local Soviets of People's Deputies.

13183/9869
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COMPUTER-AIDED WORKPLACE OF A DESIGNER TODAY AND TOMORROW

Minsk NARODNOYE KHOZYAYSTVO BELORUSSII in Russian No 1, Jan pp 14-15

[Article by V. Ponomarev: "Computer-Aided Workplace of a Designer Today and Tomorrow"; the first two paragraphs are an introduction with an inset computer-generated drawing of five horse silhouettes rotated at different angles to make a star-shaped pattern]

Look at this picture, dear reader. How long do you think would an average designer take to draw it? Even a gifted designer would probably not cope with it at all: One has to be an artist to do it. Yet this is not an artistic drawing but an India ink technical drawing. It took just a few minutes for the computerized plotter to draw it. Note: It did not copy it or draw it according to a predetermined program but drew the picture from a few "end" points and bend points ...

This is of course just a facetious picture, but it is only logical to assume that the machine will draw with an equal ease the optimal contour of a complex cam, the profile of an aircraft propeller or the shape of a hydraulic turbine. These are just a few of the potential applications of an ARM [automated workplace of a designer].

ARMs are currently made in the USSR by plants in the subordination of four ministries. The equipment sets produced by Gomel Factory of Radio and Technological Equipment are probably not the best of all. Yet it is here that ARMs were made for the first time and only here that they are being manufactured today in large batches. This means that it is the Gomel plant which "calls the shots" in this field of electronic technology.

This magazine has already covered the automated workplace of a designer two years ago in an article entitled "A Designer's Electronic Assistant." There is no need, therefore, to repeat what was said then.

The plans discussed two years ago have been mainly fulfilled by the factory. Second-generation ARMs are already being manufactured and used successfully at many enterprises. They are characterized by a higher technological level, compact size and reliability, as well as new software. But the major distinctions are determined by different features.

These units make it possible to use simultaneously several video terminal devices. A terminal (or digital-graphic display) is the tool which opens access to the electronic brain of a mainframe computer with its broad potential. If previously only one designer (process engineer or scientist ...) could "communicate" with the machine, now dozens of users located at hundreds of meters and even at a few kilometers from it have access to it.

These advantages can be illustrated by a simple example. The ARMs are of course used for the design purposes at the design office of the Gomel factory itself. After a multiterminal complex had been created on the basis of an ARM last year (several displays were linked together), the efficiency of its use improved even in the early stages by more than two and half times. This is equivalent to purchasing an additional "one and a half ARM" at a price of hundreds of thousands of rubles ...

Another basic difference of the second-generation complexes is their problem orientation. For example, they may be tailored to the needs of electronics, manufacturing, microprocessor systems, programming or the production of textual documents.

Most interesting today is the engineering "profile" of ARMs. In electronics ARMs have been used successfully for a long time. That area, however, is typically limited to the production of relatively small aritcles such as printed circuits. In engineering, however, one has to deal with machine tools and instruments, cars and planes, ships and many other products. The problems to be solved here are also much more difficult. But in this area ARMs until now have found it difficult to take root.

... We are at Gomselmash [Gomel Association for Production of Agricultural Machines]. Half a year ago a latest-generation ARM with an engineering problem orientation was installed at the office of the chief designer. In the next few years, another four such sets will be purchased. But even today the general designer and chief of special design and technical bureau for production automation [SKTBAP] has issued an order prohibiting design work done without the use of a computer. It goes without saying that the work norms for engineers and the planning of their activities are now based on design work quotas that take into account the use of computers.

The list of functions which, according to documents, are accomplished by designers at Gomselmash with the use of a computer include most of the more laborious operations that make up the daily work of a designer. This includes the design of V-belt transmissions, rolling shafts and supports, all kinds of gears, as well as springs and spliced joints and the forecasting and optimization of the machine fleet ... About 40 percent of the staff at the chief designer's office, which according to these documents have a decisive role to play in the creation of new technology, are "encompassed" by computer-aided design operations.

Let us, however, take a look at what is behind this high percentage. How has the work of designers changed? What is the real benefit of at least partial automation of this work? As is seen from the plans, in 1986 the

share of products manufactured at the factory on the basis of computer-generated documentation will amount to just 0.06 percent of the total output! That means that the ARM plotter will draw a daily average of just one elementary drawing of the size of a typewriter page. Actually, today it is not even doing that much ...

The ARM 1.09/CM equipment complex was installed, launched and accepted for operation in June 1985. Because of a lack of appropriate space, it was installed near the factory management office in the building of Gomel Polytechnic Institute. For reaching the complex, one has to leave the factory premises and walk a good third of a mile. This is, of course, inconvenient, but what can one do: an order is an order. On the other hand, the operators servicing the complex would also have a troublesome life if the laboratory rooms, where everybody is supposed to wear a white smock, would be crowded by designers from dawn to dusk.

But it turns out that designers are not showing up. The mathematicians mentioned just two or three of the hundreds of designers at Gomselmash to have ever turned to ARM for help.

One of them, Aleksandr Trestinskiy from SKTBAP, showed a computer-calculated data compilation for a gear set for Polesye Farm Combine. Indeed, it is highly efficient: The computer produced the results of these highly complex calculations in a few minutes. Even that time was spent by the printer: the electronic brain works instantly. Even for filling out the input data the designer took more time than this, not to mention the manual calculations which would have taken days.

The computer made the following conclusion: The gear set fails to provide the required service life of the transmission. Negative results in research are also a result. But calculations are just one of many and by far not the most important "specialty" of an ARM. The potential of the equipment is not currently utilized even to one-tenth of one percent. Why not?

First, there are technical problems. For example, a shortage of magnetic information media. The ARM has 15 cassettes, 13 of which are filled with programs and tests. "What can one do with the remaining two cassettes?" the programmers ask with a shrug. Indeed, the machine's "library," the ARM's electronic brain, is as yet empty. As a result, the designer cannot use it as a consultant, cannot work displays in a dialogue mode. Only a designer can fill the computer memory. But, aware of the limited storage capacity, the designers are hesitant about it and mostly rely on their own memories and reference books. This is a vicious circle.

Another problem is the unreliability of the hardware of the ARM. Ever since the service team from the Minsk factory "commissioned" the equipment set and left, the failures have been regular. Now the processor is "down," now the power source, then the drawing panel ... True, sometimes, neighbors from Gomel Polytechnical Institute come to the rescue: They also have an ARM used for training. The personnel there are more experienced. It is the people from the Polytechnic who helped assemble one working display

out of several constantly failing Grafit units. But they are not miracle workers, either. Days pass before servicemen show up, and the equipment in the meantime stands idle.

Once the specialists from the Gomel factory were invited here: "Come take a look at how your equipment is working." They became defensive: "We do not manufacture the equipment. We receive it under cooperative contract and put the sets together. But, of course, before we do so we check out the units." "Did you check out this controller?"

"Certainly! Don't you see the seal of our technical quality inspector?"

"How can it be that you checked it if it is impossible to plug it in: the 'neutral' and the 'phase' wires have been mixed up in the plug ... "

So there was an embarrassment. But this is not the main problem. That ARM components fail once in a while is not a disaster. Technology is technology: If you don't oil a wheel it won't turn. For that reason, according to the factory manual, the ARM must be serviced by 11 people: engineers, fitters and technicians. But only one of the eight employees on staff of the SAPR department is a fitter. The rest are specialists in management automation systems, graduates of Mogilev Engineering Institute. Their job is not to "oil" the machine but to create software and receive the end-products: calculations and design documentations.

Drivers whose licenses are suspended are sometimes transferred to work as "mechanics" for a couple of months. This is viewed as a punishment: The work is harder and the wages lower. Here we have a similar picture, with the sole difference that this disenfranchised position of the programmers is not temporary but, as it were, legitimized. The personnel schedule of SKTBAP does not mention electronic engineers and mathematicians at all. They are all listed as designers. The guys are young and still full of enthusiasm; for the time being they are content with their "underhand" position, despite the tangible loss in salary.

Obviously, this is an abnormal situation. But repeated requests for legalizing the positions of specialists of new professions at SKTBAP have been regularly rejected by the Office of Labor and Wages. And yet we are not far from the time when there will be a video terminal as a minimum in every department. Every designer will have access to electronic libraries from the workplace. Will this, however, produce the desired effect? Even if well-trained specialists are not always capable of communicating with the computer, what can one say about the rank and file designer? Wouldn't a terminal be for them just a nice electronic toy? One of the employees actually said, "If there were any benefit from the ARM, if the programmers were really needed, they would be paid appropriately rather than being held for poor relatives."

How can one argue with that?

But one has to argue. Because putting five ARMs in place by 1990 is not just the wish of enthusiasts. A reorientation of the technological policy has already been undertaken in the industry, and the only possible decision has been made: Reshape the technological thinking of every designer as fast as possible. The logic is simple: If you want to learn to swim you have to wet your feet. So the designers, whether they like it or not, have been placed in a situation where they can no longer work without a computer.

There is also another economic aspect of the problem. The ARM, which is half-working today at the SAPR sector, costs 600,000 rubles! Even for such a gigantic organization as Gomselmash, this is not cheap, so that thought has to be given already to ways of ensuring that the quantitative increase in the size of the SAPR sector brings about a qualititive breakthrough in the development of new agricultural machines.

Unfortunately, not all problems can be handled by the machine-builders themselves. One is the creation of a bank of applications programs. The basic software supplied with the engineering ARM is like an engineer's graduation diploma. Such an engineer has yet to learn how to solve the practical engineering problems. The programmers at the factory are not equipped to handle it.

At one point, in order to assist the users of computer technology, efforts were initiated to build a national fund of algorithms [SFAP] or a bank of applications programs. It was expected that every designer, having used computers to solve his particular production or research problems, would immediately make the program available to SFAP, where it could be used in similar cases by others. But either the "mailing" procedure was too cumbersome or for some other reasons, most of development engineers preferred to hold onto their software and never rushed to make it available to the national fund.

It is curious that even the Gomel factory cannot utilize its own product to its full capacity. The reason is the same: a shortage of applications programs. Even this enterprise is incapable of providing for its needs from its own sources. The people at the factory, however, have one advantage over all other users. When other enterprises turn to them for help as the creators of ARM, the people at the factory first of all ask: "Show us what you have taught our ARM. Show us your programs." Sometimes they find a lot of use for themselves. For example, one of the leading institutes of the Ministry of the Light Industries is using an ARM successfully for pattern-cutting of rolled fabrics. The Gomel factory, however, had a similar problem for the pattern-cutting of sheet steel that it failed to resolve. But the two operations have the same principle (and the same program!).

There are also things to be desired that concern the creators of ARMs. As a matter of fact, they are aware of their shortcomings. E. Andreyev, the assistant chief engineer at the Gomel factory, comments:

"Just a couple of years ago, we were often asked, 'What is an ARM? What is it needed for?' Skepticism and mistrust are inevitable when introducing a basically new technology. Now, this is all behind us, and we are talking with fellow believers and not novices. What we hear now is, 'Your ARMs are imperfect. There are too few of them. Give us more and make them better! Give us a color display rather than a black-and-white one, three-dimensional graphics and a rapid plotter.' Wherever our technology has such exacting users, it produces, as far as I know, sometimes millions of rubles in savings. This is why, believe it or not, we are even happy when we hear criticism. That means that there is a vigorous demand, and demand, of course, generates supply.

"Indeed, isn't it paradoxical that our 'automatic drafter' uses India ink or ballpoint pen--tools that do not make for high speed? Unfortunately, there are quite a few interdepartmental and interindustry barriers which stand in the way of supplying ARMs with most up-to-date technology. The fact is that we do not make everything ourselves. But whatever hangs on the factory will be made. In the nearest future, the designers will receive color displays and three-dimensional graphics."

There are grounds for this optimism: We know that the collective of this factory backs their words with deeds. In conclusion, a final word addressed to the skeptic (and skeptics) from Gomselmash. Now is no time to dicker about who is more "expensive": a programmer, a designer, a engineer or a computerized designer. This is wrong, because each costs the nation quite a lot, and the solution is to combine their potentials for the best possible results.

9922
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ENGINEERS ARE MASTERING COMPUTER-AIDED DESIGN

Minsk NARODNOYE KHOZYAYSTVO BELORUSSII in Russian No 1, Jan 86 pp 12-13

Article by Yu. Karpilovich, cand. techn. sci., chief engineer, Minsk Production Association for Computer Technology, I. Matyshev, department chief, and N. Konoplyannikov, department chief: "Engineers Are Mastering Computer-Aided Design"; the first two paragraphs are an introduction]

[Text] The current state of industrial production requires increasing input of the work of engineers. Coping with this task is inconceivable today without the use of automation.

The Minsk Production Association for Computer Technology [MPOVT] has been increasing every year the scope of work in creating, introducing, and operating systems of computer-aided design [SAPR].

The use of computers by engineer services follows two main lines in the technical preparation of production processes: 1) creation and development of SAPR systems for designers of computer assemblies and modules, and 2) creation and development of SAPR for technological preparation of production [TPP]. Both these areas are developing in the framework of an integrated plant management automation system.

Launching the production of a new ES-1061 computer made it necessary for the designers and mathematicians at MPOVT to master a new design tool--the computerized development of computer assemblies and modules. It was decided to take for the base the Unified System of Computer-Aided Design of Computer Technology [ESAPEVT] developed by a group of organizations across the country. It should be said today that without introducing the system into operation and without development by the Minsk Production Association's own forces, it would not be able to resolve all the problems it had to deal with in developing and producing the new products bearing our plant's logo. In particular, when developing the ES-1061 computer more than 70 percent of all design documentation was developed with the help of ESAPEVT.

A product isdescribed in ESAPEVT by an informational (digital) model. The models include design solutions, electronic parameters of the circuit and all the data necessary for making the product on a computerized machine. The design becomes the process of interaction of the designer with such a digital model of an assembly or a module. When looking for an optimal

solution, the developer varies the model repeatedly, introducing various modifications. The practical decisions are made on the basis of a mathematical experiment--mathematical modeling. This feature of the system makes the processes of introduction and adaptation of new products developed by other organizations a flexible procedure. The concept has been advanced of transferring informational modules of computer assemblies directly onto magnetic media from the developer organization to the manufacturer organization. The new product, represented in the form of digital models on a magnetic medium, is inscribed harmoniously into the system of technical preparation of production in place at the manufacturing enterprise.

What are the benefits the system gives to an engineer developing computer assemblies and modules?

First, a two-to-three-fold increase of productivity. The engineer is relieved of laborious operations such as the layout of wiring in the layers of a printed circuit, and development of design documentation in the form of tables and control programs for computerized equipment.

Secondly, ESAPEVT ensures a high-quality solution of problems it handles. The possibility of checking the equipment for compliance with various requirements and parameters, coordinating them, and reviewing them in a complex whole is a major factor in the development of new solutions.

Thirdly, the current stage of ESAPEVT, which is a new tool of development engineering, offers a new technology of design work. The mathematical informational modules of a computer assembly or unit and the respective software allow performing entirely new design and development functions which could not be accomplished by conventional techniques or would take an exceedingly long time. For example, the design of a printed circuit board of a size 360 x 360 mm, if done manually, takes four to five months, while with SAPR it takes five to six hours of computer time.

Fourthly, the development engineer designs a product in the system in a virtually continuous cycle. The possibility of receiving from the computer a control program corresponding to the informational model and presenting it the form of punched tape or other machine-readable media in parallel with the design of products makes it possible to efficiently integrate ESAPEVT with automated equipment making up part of a flexible production system (FPS).

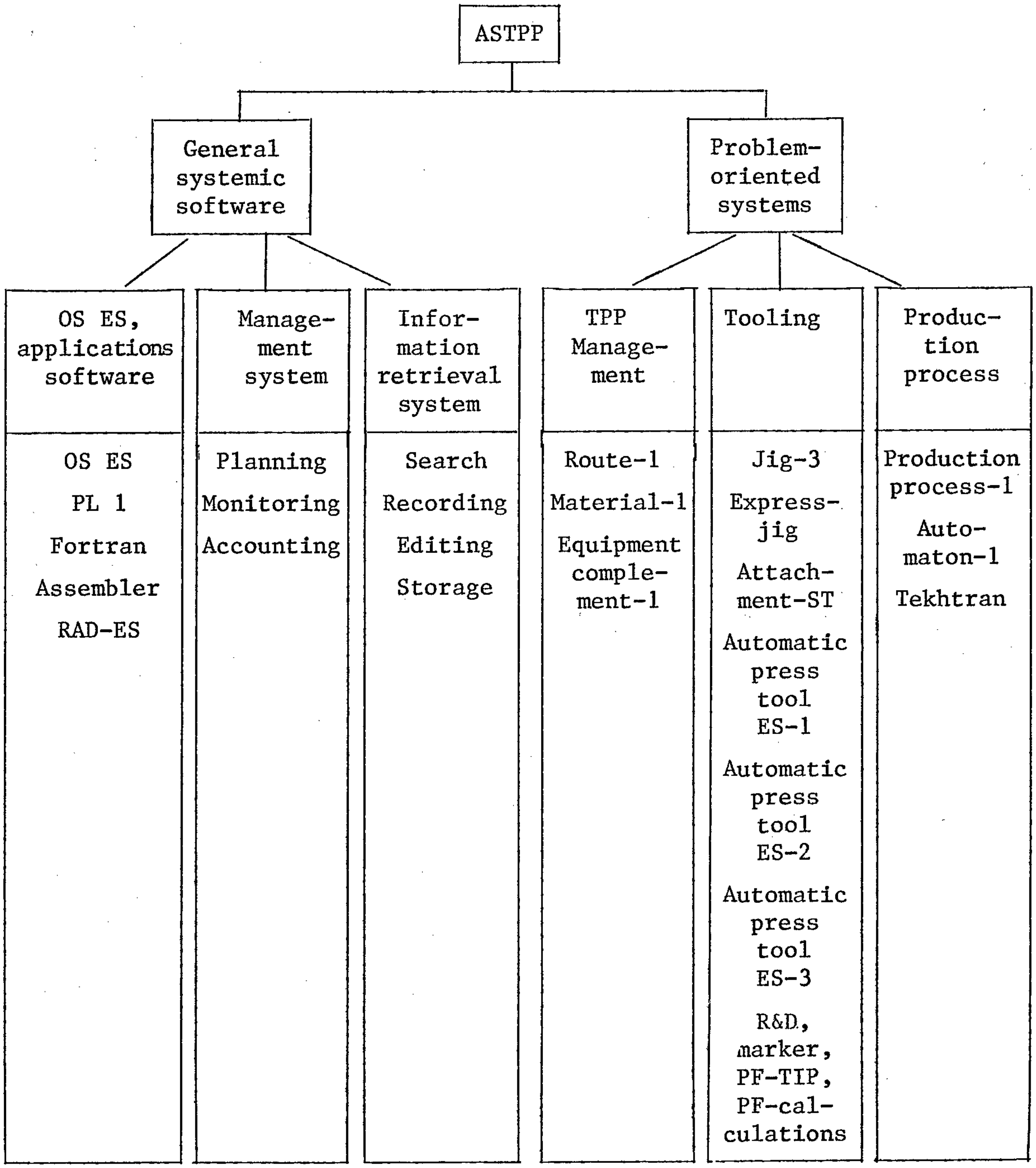
The Association's staff has developed a software which, proceeding from the results of the design project, generates in a continuous cycle a complete set of control programs for the equipment manufacturing computer assemblies and units.

For example, in the manufacture of printed circuits all the main processes (the drawing of photo templates, drilling of holes, testing of logic circuits and testing of printed circuits) are performed by control programs operating automated equipment.

Exceedingly important in raising productivity and the quality of products is the introduction of a set of automated equipment manufacturing the core computer component--the typical replacement element (TRE). Currently, basic operations (such as installing microcircuits on printed boards and TRE checking and adjustment) are performed on computerized equipment by using the programs obtained by means of SAPR.

Another important line of activity of an engineer at a modern enterprise is the technological preparation of production. It involves the solution of a set of problems in developing the technological facilities and tools and the production processes, writing the control programs for NC machines and management of TPP. Generally, it is a complex set of organizational and technological activities and engineering-technical work aimed at launching the production of new or modernized articles. The cost of TPP in a mass-scale production may account for 30 percent or more of the total cost of manufacturing. A major trend in improving TPP, therefore, is the use of computers to reduce labor-intensiveness and costs and to raise the quality in solution of technological problems.

Computers began to be introduced into the professional sphere of process engineers in 1977. The first steps in this direction showed that creating SAPR for TPP is a difficult problem. The absence of the appropriate technological facilities, methods of design and advanced formalization theory and a general-purpose mathematical and programming software for solution of TPP problems was and still is the main obstacle to developing SAPR for TPP. Despite these difficulties, the enterprise, in cooperation with the Institute of Technical Cybernetics of the Academy of Sciences of Belorussian SSR and several other organizations in the country, has developed, introduced and is operating automated systems that allow solving a broad range of problems on a computer. These systems today are capable of designing press dies and attachments, matrices for inscription marking, control programs for NC presses and machine tools and production processes. They can calculate the working dimensions for pressform components, select the nomenclature of parts for robotic-technological complexes, evaluate the labor costs of a product, etc. The core of such a system is a set of mathematical methods, a TPP theory and software. Combined with organizational forms at the enterprise, this complex is a man-machine TPP system--an automated system of technological preparation of production (ASTPP) of an enterprise (see the diagram). The system reduces significantly the cost and time of TPP, improving drastically the productivity of a process engineer. This is illustrated by the Osnastka [tooling] SAPR, as described in the table. Working with the Osnastka SAPR, an engineer only spends time on making a number of early creative decisions concerning the design and data preparation. The rest of the design job, including the making of final drawings on graphics-design automata [ChGA] is done by the computer. All the systems that have been developed operate in an autonomous mode. For their operation a separate automated design section has been organized. The encoding and preparation of assignments are performed by designers at the office of the chief process engineer.



The operation of ASTPP is based on an ES-1061 computer with a ramified network of alphanumeric displays installed at the workplaces of process engineers. The computer operates in a real-time mode, allowing the user to work with the systems desired practically instantly. The operation is organized as follows. The user, seated at a display screen, works out the initial data. After this work is completed, a special operation group takes over, which is responsible

Specifications of the Design Process in SAPR

SAPR Code	Object of design	Time for manual devel-op-ment	Time for computerized development		Com-pleted pro-jects, first 6 mos. of 1985
			Pre-paring descrip-tion	Calcu-lating on com-puter	
Express jig	Jigs for drilling of flat components	12 hrs	15-20 min	3-5 min	58
Automatic Press Tools ES1, ES2 & ES3	Sequential-action press tools for punching and com-bined action	20 hrs	30-60 min	15-20 min	132
R&D	Tools for presses	8 hrs	20 min	5 min	163
Marking	Matrices for marking	8 hrs	30 min	10 min	60

for the computer-aided design of TPP functions, including the generation of drawings on ChGA. At this stage, the work is done by computer operators, while the engineer is now free to work on creative problems.

Currently, 70 percent of all production processes and 20 percent of tooling processes are performed at the Association as an automated procedure.

The experience gained by the plant in introducing computer-aided design systems opens prospects for creating an integrated system of automated design.

[Boxed insert by Zh. Tkachuk: "Using a Technological Design Line"]

An example of a successful use at a small construction organization of the achievements of modern science is the introduction of a computer-aided design system based on a technological design line [TDL] at the Brestgrazhdanproyekt Civil Engineering Design Institute.

The TDL for the design of foundations of buildings and structures has been created at the Institute for the first time in the USSR. A novel feature in the design work is its complete automation--from calculations to design on the basis of calculated parameters to graphics to evaluation of technical-economic characteristics. All this has made possible the introduction of multivariant design, which produces substantial savings of materials, while at the same time significantly raising productivity of development engineers.

As a result, the Institute has achieved a level of automation of design work that is the highest in the system of Gosstroy of the Belorussian SSR. The productivity has been increased threefold. For Brestgrazhdanproyekt Institute alone, the savings amounted to 320,000 rubles, and if the use of the system at other design organizations and departments is considered, more than 3 million rubles in Belorussia and 40-45 million rubles on a national scale annually.

A separate design automation department has been created at the Institute. The plans of the department call for further advances in this important matter.

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PRODUCTION PROCESS IS DESIGNED BY A COMPUTER

Minsk NARODNOYE KHOZYAYSTVO BELORUSSII in Russian No 1, Jan 86 pp 18-20

[Article by A. Kononovich, chief of the Local Industry Board of Minsk Oblispolkom, and L. Tkachenko, cand. techn. sci., laboratory chief at Central Scientific Research and Design-Technological Institute of Management, Organization and Technology: "Production Process Is Designed by a Computer"; the first paragraph is an introduction]

[Text] In 1983 issue 11 of this publication (then appearing under the title PROMYSHLENNOST BELORUSSII), we carried an article by A. Kononovich, then director of the Orsha Tool Factory. The article described the initial stage in introducing computer technology for factory management and the technological preparation of production. The present article is a continuation of that story. The system of computer-aided design of production processes [SAPRTP] for the manufacture of cutting tools that has already been put in place at the factory is described by A. Kononovich (currently the chief of the Local Industry Board of Minsk Oblispolkom) and L. Tkachenko, candidate of technical sciences and scientific director of the project, who is also a laboratory chief at the Central Scientific Research and Design-Technological Institute of Management, Organization and Technology [TsNIITU].

SAPR of production processes developed for a factory is an organizational-technical system which consists of a set of equipment for computer-aided design which is linked with units of technological preparation of production [TPP] and engaged in automatic design operations. Developing a SAPRTP is labor-consuming process; at all of its stages its participants include not only the design organization but the user enterprise as well.

Experience has shown that systems of computer-aided design which reproduce mechanically the processes of technological preparation of production as they exist at an enterprise do not produce the desired effect and do not have the flexibility that is necessary in the situation of the constantly changing production environment at a factory. A TPP at an enterprise should be based on a strictly scientific foundation and up-to-date production processes that preclude subjective decisions or random phenomena caused by the external influences from related enterprises.

In view of these facts, substantial preparatory work was carried out at the the Orsha Tool Factories. The nomenclature of cutting tools produced by the factory was defined and standardized and the specializations of

workshops and production segments redefined. In addition, standard production processes were developed and introduced at the factory covering the entire nomenclature of standardized cutting tools and incorporating advanced technological solutions and knowhow. No less important are processing regimes and time schedule rates justified technologically. A computer center has been created and the first stage of the plant management automation system has become operational.

The SAPR of production processes at the Orsha Tool Factory is based on the hardware facilities at the computer center (ES-1022 computers) and functions under the control of ES OS.

The developers on staff at TsNIITU used in SAPRTP a design method based on typical technological processes [TTP] and the method of individualized design. The former is used for standardized cutting tools made in several variations. Individualized design is used for cutting tools covered by no typical technological processes. The former type of design certainly deserves greater attention because it is the predominant one. In that case, the efficient solution alternatives are accepted as standards and entered into the computer either as information files or as design algorithms. The task is then reduced to finding the appropriate typical technological process and adjusting it to the specific characteristics of a given cutting tool. The adjustment involves specifying the composition of the technological transitions in the operations, the types and sizes, models and brands of equipment, attachments and tools within the types, as defined by the technological process, and also the variable dimensions of the cutting tools within one type; the initial data are determined for evaluating the treatment conditions and these conditions are defined.

A typical technological process, as recorded in a standard form on an operations chart, has to be prepared for computer input. To this end, the information is written in tables containing data extracted from routing or operations charts or obtained as a result of TTP analysis. In addition, tables of parameters have been prepared to define the values of the elements of a technological process.

The computer-aided design on the basis of TTP is organized as follows. According to the symbol of the cutting tool, for whose manufacture a production process must be developed, the appropriate TTP is read out of the magnetic disk. The TTP is processed sequentially starting from the first operation, while the design of operations is based on transition steps. As a result, printout files of the system output documents are formed. If production conditions or typical technological processes are changed, their formal models are updated.

The algorithms of individualized design of technological processes are similar in form to the above processes but differ significantly in their contents, because they include formulas for evaluating the structure and parameters of production processes according to the variable dimensions of cutting tools.

The SAPR of production processes consists of service and design subsystems. The former include Dispatcher, Archive and Document subsystems and a subsystem for interface with production management automation systems.

The Dispatcher subsystem controls the design operation and the processing of all kinds of data. The input data for the subsystem are job assignments specifying the operations to be performed and the numeric values of the parameters. The job assignments are constructed in conformity with the Russian syntax, providing for greater clarity.

The Archive subsystem is intended for processing information that can be represented in the form of reference tables or correspondence tables. It allows performing the following actions with tables: input into working memory, registration on a disk, reading out of information file, processing and correction of tables.

The Document subsystem is responsible for printing out the results of computer-aided design in the form of routing and operations charts, equipment tooling schedules and charts with technical-economic characteristics.

The subsystem for interface between SAPRTP and production management automated system forms the data files for the latter.

The design subsystems develop production processes and are expected to generate information necessary and sufficient for formatting the appropriate technical documentation. Their composition is determined by the specifics of a particular tool-manufacturing line.

The core of the system's information base consists of data describing the typical technological processes. These are the data that are identical for all the tools within a given TTP; only numeric information is included, with no text elements. Texts are brought together into general tables, where the elements of all TTP are contained. As a result, because of the total absence of duplication of texts, the external memory for the storage of information base is greatly reduced; in addition, the correction of texts is simplified.

The developers of SAPRTP and the engineers of the Orsha Tool Factory have provided the capabilities for the performance of the following job assignments:

- the correction of data describing TTP (elimination or addition of TTP; elimination or addition of operations in a TTP; replacement of an operation by another one; adding a new modification of a tool; modifying the TTP parameters; and production of reference data describing the contents of above information both in its entirety and partial);

- correcting general tables (introducing a new table; eliminating a table; adding new texts into a table; replacing a text or a line of text; replacing a group of characters by another group throughout the table; and producing specific reference data);

- processing of specialized tables; and
- design of production processes and the generation of the appropriate technological documentation.

The design results are presented in the following documents:

- routing chart;
- operation charts for mechanical processing, cold pressing, electrochemical and fitting treatment and technical inspection;
- schedules of special tooling, fitting and installation, measurement and abrasive tools and grinding wheels;
- charts of standard work quotas and wages; and
- charts of technical-economic characteristics with labor quotas for individual jobs and different groups of equipment; material consumption rates; material utilization rates; metal utilization rates; and other data.

It should be clear from this brief description that SAPRTP is a complex technical object and requires well-trained specialists for operating it. In view of this, a SAPR sector has been created as a unit of the chief production engineer's office at the Orsha Tool Factory. In addition, programmer-mathematicians are on the staff of production management automation system department, who are involved in software design. The staff of TsNIITU gave technical training sessions for them, and then the factory set out to launch the system.

At this point, however, various factors began to be observed which ultimately are going to move back the time of operational intorduction.

First there is the psychological barrier for the factory's process engineers. Odd as it may seem, it does exist. Even the process engineers who have taken part in the creation of the system for several years were skeptical about automation. They had to learn thoroughly how to prepare the input data for design, how to describe in formal terms a new typical process to be entered into the computer. A breakthrough event was the creation of the first working processes on the computer. At that point, the psychological barrier was broken.

Another important factor was the need for maintaining all the decisions and information in the system up to date. The information base was created during the course of development of the software as a simultaneous operation. This was a long and labor-consuming process. Of the 70 typical processes registered on machine-readable media, 25 turned out to be invalid by the time the system was ready for industrial operation, because, in the meantime, the factory had changed the nomenclature of tools manufactured. Those that remained were no longer utilized, because there was a lack of appropriate orders.

As a result, a situation arose where, on the one hand, the factory had SAPRTP but, on the other, the production processes were developed manually. It was necessary to urgently enter new typical processes into the system, which made it possible to produce the technological process descriptions directly for workplaces in the workshops.

A new problem arose here. The creators of the system have provided the possibility of entering the typical processes into the information base both by filling out forms with subsequent punching of data and directly through the display terminal with no written records. In the former case, it takes two to three months to enter one TTP into the data base, while in the latter just two or three weeks. After learning how to use the display terminal available to the system designers, the process engineers at the factory refused to prepare the data for the information base manually. They want a display terminal, but there are no terminals at the factory.

It was also necessary to think about the organization of TTP at a factory operating in a SAPR environment. Here, too, many questions were raised. Who should decide which operation should be handled by the computer and which by traditional techniques? What is the role and place of standardization bureau? What documents should be stored in the archive? In what form should the production processes be presented to those at workplaces?

All these questions have been resolved by now. The SAPR of production processes at the Orsha Tool Factory has become a vital component of the complex workings of the factory. The second stage of the system is currently being developed, which will make it possible to design production processes in a dialogue-type operation mode and encompass by automation the entire nomenclature of products manufactured. Today, SAPRTP is preparing to assume a new function: It will become a component of a flexible automated production system. This, however, is the subject of a future story.

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STANDARDIZATION OF PROGRAM-PROCEDURAL SAPR COMPLEXES AS PRODUCTS FOR INDUSTRIAL AND TECHNICAL APPLICATION

Moscow STANDARTY I KACHESTVO in Russian No 3, Mar 86 pp 25-28

[Article by V.F. Kurochkin and D.V. Krivomazov, VNIIINMASh]

[Text] In the 10th and 11th five-year plan periods, standardization in the SAPR [automated design system] area resulted in complexes of state standards, procedural instructions and recommendations, that have regulated the structure of SAPR and processes of development thereof and formed a certain base of standard methods and solutions for performing and documenting the development of automated design systems. These standard documents apply to the development of all SAPR without exception, no matter what type object is developed (i.e., SAPR at large). They facilitate the establishment of a uniform procedure for the design, functioning and development of SAPR.

So far, however, the existing NTD [technical standards documentation] has hardly lead to the reduction of the time and costs of systems development. The reason is that components of software and data base organization and support, as well as combined equipment complexes that are part of each SAPR, have not yet become standardization objects. At the same time, up to 50% of the cost of developing SAPR for specific projects is in the system design.

That is why the principal direction in standardization in the SAPR field during the 12th five-year plan period is standardization of typical components that are part of every SAPR.

SAPR standardization program for 1986-1990, approved by Gosstandart resolution in August, 1985, plans, for the first time at the state level, the development and standardization of 23 program-procedural complexes [PMK] as products for industrial and technical application. This is a qualitatively new direction in both state and industry standardization, and it presently needs certain procedural support.

An important role in the development of this direction is played by GOST 23501.201-85 "SAPR. Equipment Complexes. General Technical Requirements". This GOST was developed on a special assignment from GKNT and approved in 1985 with the introduction date 01.01.86. It has established groups of products for industrial and technical application in SAPR.

Among these products are components (hardware, software and data base organization and support), program-procedural and program-technical complexes.

A PMK must become the principal, and the most widely used, industrial object in SAPR. Its concept is based on the following requirements:

1. The design procedure should be regarded as an indivisible process that requires for its realization both the software and information and procedural support. A project procedure is a set of project operations, automated performance of which results in obtaining a finite description of the design object or of a part thereof.

2. Maximum independence of data base organization and support from the software within the PMK framework. This is a very importanrt requirement. The thing is that, in spite of a considerable software stock in existing libraries, it is practically impossible to use them in SAPR development, due to software dependence on data and the form of presentation thereof. For a long time, of paramount importance was a program, designed in accordance with the YeSPD [Unified System of Program Documentation], that realized, as a rule, in a batch mode, an algorithm rigidly related to data. Among specific features of these programs are dialog modes and program operation with large volumes of frequently changing data. It is very difficult to use such programs in SAPR, as changing the contents of information in data bases leads to almost complete rework of the programs.

3. The development of PMK must be performed, taking into consideration their subsequent application in many organizations and enterprises that develop SAPR for specific objects. Hence the requirement for maximum adaptability of SAPR to specific conditions of these organizations.

To meet this requirement, some industries have designated base enterprises where a SAPR for a specific object is developed ahead of schedule, and then the debugged automation equipment is being transfered to related enterprises in the industry. However, one should remember that base equipment and equipment complexes that are common for various systems and are fit for copying, must be identified from the very beginning, and their development should be performed, taking into consideration maximum subsequent adaptability in the conditions of future enterprises-users.

4. The impossibility to completely formalize design procedures calls for an active participation by the designer and the manufacturing engineer in the process of objects design. Therefore, within the framework of procedural support, linguistic means must be provided in the PMK for user's communication with hardware and data base organization and support components.

5. Separate, within the PMK framework, documenting of software, hardware, data base organization and support and procedural support components.

After taking into consideration the above requirements, GOST 23501.201-85 defines PMK as **interrelated set of software components and components of procedural support and data base organization and support (including**

linguistic components) necessary for obtaining a complete design solution for the design object (or a part thereof) or for performing unified procedures.

A **program-technical complex** [PTK] is an interrelated complex of PMK and hardware. Practically, PTK are created for simultaneous execution of several procedures; therefore, a PTK includes several PMK, realization of which is provided by selected hardware manufactured in series production.

In order for industrially manufactured automated workstations [ARM], that, according to GOST 23501.201-85, are part of program-technical complexes, to fit this definition, operating development of PMK for various applications must be provided.

Depending on the application, PMK are divided into **general-system** and **base** ones.

General-system PMK are intended for insuring the workability of a SAPR at a system level and for performing unified procedures. Coupled with an operating system, they form an environment in which basic PMK function, and the design process is shaped up and performed. General-system PMK are invariant with respect to the design object, i.e. actions that a designer performs using general-system PMK do not affect the specificity of the design object.

General-system PMK have wide application and universal character. The presence of general-system PMK in SAPR frees the designer from the majority of routine operations and makes his work more creative. That is why general-system PMK must be developed and state-standardized in the first place.

This also involves large expenditures for the development thereof (compared to base PMK). Therefore, it makes sense to raise a question of the mimimum number of general-system PMK that would, as a complex, provide the realization of the most significant design procedures. Such minimum set of general-system PMK can be called the general-system core of SAPR. It must include the following:

SAPR dialog monitor that performs automated scheduling and control of the design process, including providing designer's access to these processes;

database management system (SUBD) that supports information needs of design procedures and partially insures informational compatibility of different PMK;

geometric processor that performs geometric simulation of design objects (shaping, structural composition, specification and simulation of surfaces etc.);

graphic processor that provides reception, processing (editing) and output of graphic information, as well as serves as a link between graphic information and the geometric model of the design object;

documenting processor that performs the development and release of design and manufacturing documentation on machine and paper media.

Not only general-system PMK that are included in a SAPR core, but also principles for organizing thereof as a whole (the SAPR core architecture) must be subject to standardization. In relation to this, the following problem arises. A unified informational model of an object that provides an internal interface between all the components of a core and access to necessary data can serve as a basis for unifying general-system PMK. However, no model can be recommended to-day that would satisfy all SAPR users. A set of standard interfaces that provide informational compatibility of components of a core can constitute an alternate basis for unifying the core. Standardization of such set of intefaces does not pose any specific difficulties, provided the core components themselves are standardized. However, if in the first case it is possible to connect applied design means to the core, if a certain limited set of requirements is met, in the second case the applied means must be complemented by specially developed interfaces with all components of the general-system core of a SAPR. Still, in spite of the awkwardness and complexity of the second method, this way seems to be more realistic today.

Base PMK are used for automated design of a certain class (type) of objects or for performing universal procedures. The first ones are called object-oriented base PMK, the second are problem-oriented base PMK.

With the help of problem-oriented PMK, the most widely used, but hardly related to design specificity procedures are performed, such as selection of the physical operating principle of an object, its structural design, evaluating the manufacturability of the product design etc. PMK that are related to the design object but reveal a specific method (approach), such as structural design that uses the finite elements method, can also be problem-oriented. State standards should be developed for problem-oriented base PMK having interindustrial application, and industry standards should be developed for PMK that affect design specificity, such as the design of functional circuits of radio equipment based on integrated circuits.

Object-oriented base PMK constitute the most numerous class that provides automated design of a class (type) of objects under the conditions of specific design organizations. The following types of complexes can be construed as object-orientd base PMK: automated design of assemblies and parts for general machine building application, design of manufacturing processes according to processing methods etc.

Widely used PMK that provide automatic design of products intended for mass application must be subject to standardization at the state level, whereas PMK that have a rather wide object orientation and not too cumbersome means for adaptation thereof to design objects and methods in individual organizations must be subject to standardization at an industry level.

Program-procedural and program-technical complexes of SAPR constitute a specific class of software products. We are only starting standardization thereof now. To regulate the problems of development, manufacturing and aplication of these complexes, it is necessary to develop two types of technical standards and procedural documentation during the standardization process: for groups of similar software that are part of the above class and

for specific versions of this software.
For a group of similar products (PMK, ARMs) state standards must be developed that regulate the required technical level and quality of products that are part of the group. These are standards covering general technical requirements, types and principal parameters, as well as rules for the development, approval, test methods, packaging, shipping and storage.

The SAPR standardization program for 1986-1990 provides for the development in 1986-1987, as a further expansion of GOST 23501.201-85, of three state standards "SAPR. Automated Workstations. Types and Principal Parameters", "SAPR. Program-Procedural Complexes. General Technical Requirements" and "SAPR. Unified Procedure for Development, Examination and Standardization of PMK".

Specific versions that are part of the group of similar products should be developed, produced and used, meeting the requirements of the above mentioned state standards. These versions fit the term "Standardized products".

Specific versions of PMK that are widely used in the development of SAPR of individual objects must be subject to more detailed (compared to the product group) standardization. The basic normative document regulating principal requirements to and parameters of PMK that are incorporated during its development, provided for during the manufacturing process and realized during the application of the complex, must be a document called "PMK Description and Application". A normative document of the "Design and Dimensions" type can serve as its tentative analog in standardizing traditional products.

The procedure for developing and documenting a PMK that is subject to standardization must conform to GOST 23501.119-83. Herein, a PMK technical proposal should provide for the development of the normative document "PMK Description and Application". A draft of this document should be sent out for coordination not later than the completion of the "Working Project" stage of a complex.

In our opinion, three levels of standard shipment to a customer (user) should be provided:

with a full set of documents insuring support and maintenance of PMK as part of SAPR and the expansion thereof;

with a limited set of documents that contain a description and application method (does not provide for the expansion of complexes);

with the application method (as a black box).

Specific composition and contents of a standard PMK that includes both material components om machine media (software and data bases with data sets) and documentation ("Specification", "PMK Certificate" etc. and the normative document "PMK Description and Application"), depending on shipment level, is presented in the chart.

Standard PMK Composition

(24) Вид обеспечения	(25) №№ п/п	(26) (27) Состав стандартного ПМК (виды компонентов на машинных носителях и документов)	Обязательность разработки компонентов и документов	Комплектность поставки стандартного ПМК: с полным комплектом (29)	с ограниченным комплектом (30)	с минимальным комплектом (31)	(28) (32) Примечание (36)
	1	Спецификация	o	o	o	o	Документ утверждается в категории ГОСТ, МУ или МР
	2	Описание и применение ПМК (нормативный документ)	o	o	o	o	
Методическое обеспечение (33)	3	Общее описание	o	+	+	+	
	4	Методика автоматизированного проектирования (методика применения ПМК)	o	o	+	–	
	5	Описание проектной операции (процедуры)	+	+	+	–	
	6	Описание языка	+	+	–	–	
Информационное обеспечение (34)	7	База (наборы) данных на машинных носителях	o	o	o	o	(37) Документы 11 и 12 могут быть объединены
	8	Описание структуры информационного обеспечения	+	+	–	–	
	9	Каталог базы данных	+	+	–	–	
	10	Описание базы данных	o	o	+	+	
	11	Инструкция по заполнению базы данных	+	+	+	–	
	12	Инструкция по ведению базы данных	+	+	+	–	
	13	Руководство администратора информационного обеспечения	+	+	+	–	
Программное обеспечение (35)	14	Программа на машинных носителях	o	o	o	o	
	15	Текст программы	o	o	+	+	
	16	Описание программы	o	o	+	+	
	17	Руководство системного программиста	+	+	–	–	
	18	Руководство программиста	+	+	+	–	
	19	Руководство оператора	+	+	+	+	
	20	Описание контрольного примера	+	+	–	–	
	21	Формуляр	+	+	+	–	
	22	Паспорт ПМК	+	–	–	–	
	23	Акт аттестационных испытаний	o	–	–	–	

Legend: o- components and documents that are mandatory for development and shipment;

+ - technical proposal specifies whether the development and shipment are mandatory;

- - shipment of the document is not mandatory.

Key:

1. Specification
2. PMK description and application (normative document)
3. General description
4. Automated design procedure (PMK aplication procedure)
5. Design operation (procedure) description
6. Language description
7. Data base (sets) on machine media
8. Description ofdata organization and support structure
9. Data base catalog
10. Data base description
11. Data base filling manual

(Key continued on following page)

(Key continued on following page)

12. Data base keeping manual
13. Data organization and support administrator's manual
14. Program on machine media
15. Program text
16. Program description
17. System programmer's manual
18. Programmer's manual
19. Operator's manual
20. Control example description
21. Log
22. PMK certificate
23. Certification test report
24. Type of support
25. Item number
26. Standard PMK composition (types of components on machine media and documents)
27. How mandatory is the development of components and documents
28. Completeness of standard PMK shipment
29. Full set
30. Limited set
31. Minimum set
32. Remarks
33. Procedural support
34. Data organization and support
35. Software
36. The document to be approved in the GOST, MU [procedural instructions] or MR [procedural study] category
37. Documents 11 and 12 can be combined

In the general case, 23 components (on magnetic media) and documents should be developed for a standard PMK, wherein only 10 are mandatory, and the need to develop the rest is specified in the TZ [technical proposal] for the PMK development. From the set of developed components and documents, subsets are formed that are sent to the user: the minimum mandatory subset includes four, and the full one includes eight documents and components.

A PMK that meets the requirements of state standards for a group of similar products and of the normative document "PMK Description and Application", approved at the state or industry level, can be called a standard PMK. But this is not enough. What is needed is interindustrial (state) testing and an organization that produces the PMK. Therefore, in the "Regulations on Unified Procedure for Development, Standardization and Funding of PMK SAPR" that has been developed on assignment from GKNT and sent to Ministries and agencies for coordination, a somewhat wider definition of a standard PMK is given: a standard PMK is a PMK that was developed as a production object, passed interindustrial or industry tests, has been approved for production by a state or industry fund, meets the requirements of approved for it state standards for a group of similar products and of the normative document "PMK Description and Application", has a PMK certificate and is provided with appropriate fitness for work warranties.

The normative document "PMK Description and Application" can have a status of a state or industry standard or of procedural instructions of an appropriate level. At the state level, all general-system PMK must be standardized, as well as that portion of base problem-oriented PMK that have interindustrial application (according to the standardization program, 23 such PMK are being developed). At the industry level, work should be organized on standardization of base problem-oriented PMK having industry application, and base object-oriented PMK. A lot of work is ahead in this area. Potentially, for each class (type) of products in the YeSKD Classifier, an object-oriented PMK for SAPR of this class of objects can be developed.

We shall note in conclusion, that the concept of program-procedural and program-technical complexes as products for industrial and technical application for SAPR has been accepted at the state level. PMK have been recognized as an effective object for both state and industry standardization. To drastically reduce development time and expenditures and make placing SAPR in service in medium and small design organizations real, it is necessary to immediately start the development and testing of general-system and base PMK and, basically, complete standardization thereof in the 12th five-year period not only at the state, but especially at the industry level.

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AUTOMATED INFORMATION PROCESSING SYSTEM FOR DESIGN AND UTILIZATION OF METALWORKING GPS

Moscow STANDARTY I KACHESTVO in Russian No 3, Mar 86 pp 29-30

[Article by V.A. Lyubimov and E.V. Petrosyan]

[Text} It is known that a flexible automated system for manufacturing parts under the conditions of series and small-series production is only efficient in the case of batch processing, when it is possible to concentrate parts, that are similar design-wise and manufacturing-wise, in specialized production subdivisions oriented towards a closed-loop production cycle.

To do this, in developing a GPS one should first analyze the existing manufacturing process in a plant, including the selection of parts nomenclature and studying the process of manufacturing thereof and the production volumes.

Because the nomenclature of parts manufactured by an eneterprise can sometimes be in the thousands, and the number of design and manufacturing parameters for grouping the parts in batches, depending on parts complexity, can be up to 50, the processing of the information using traditional methods, even with the participation of a large number of skilled professionals, is practically impossible, and it is neceesary to look for new methods for performing this work on a computer.

A serious obstacle shows up in the way of solving this problem, related to the fact that basic information on the design and manufacturing of a part, reflected in the design and processing documentation, cannot be completely recognized by a computer with subsequent reproduction of the part's image, and therefore a part's description is necessary that is adequate to its drawing and manufacturing image, and in a language intended for input and processing of information by a computer.

So far, both at an enterprise and in an industry, a system of assigning a number to a product and its design document in accordance with a functional characteristic or the name (MNSChKh [machine building standard "System of Drawing Keeping"]) has been in effect. This system did not have other designations that would relate a part's design to its characteristic per MNSChKH. Characteristic examples of the absence of interrelation between part numbers and design characteristics thereof when the names and part numbers are the same, are presented in Figure 1 for parts of "Flange" and "Bushing" types.

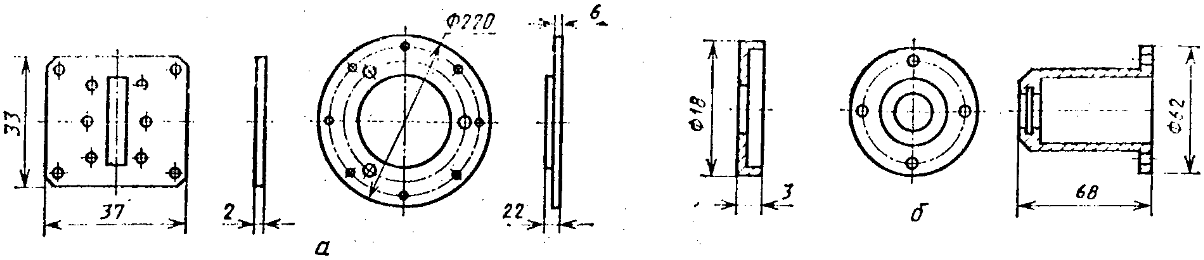

Figure 1. Examples of geometrically different parts with the same names and part numbers per NO.000.05 MNSChKh: a- flange (XX8.230.XXX per MNSChKh); б - bushing (XX8.223.XXX per MNSChKh)

It follows that, for designating a drawing in the case of automated information processing with the goal of analyzing and grouping parts for GPS, it is impossible to use a decimal characteristic that mainly determines geometry of a part. A need arises to use a different system for classifying and numbering drawings that would also use design and manufacturing characteristics.

To this end, and for solving the problem of systemizing, cross-usage and unification, one can successfully use a YeSKD Classifier, developed by VNIINMASh together with other industries. This Classifier is a unified non-"personalized" system for numbering products and design documents per GOST 2.201-80. It is now undergoing trial testing at an enterprise.

Machine and instrument parts are placed in six independent classes 71 through 76. In five classes of parts (71-75), at the first classification level a characteristic of basic geometric shape is used. This characteristic is the most objective and stable; it reveals significant features of a part irrespective to its functional purpose and usage in other products. The geometric shape characteristic is rendered concrete at subsequebnt classification levels.

Class 76 classifies machine tools (drills, taps etc.) and industrial equipment parts (punches, dies, cutting inserts etc.)

The experience in using the YeSKD Classifier at the enterprise has demonstrated that, in spite of the wide variety of manufactured products, the classification system made it possible to code all parts with sufficient, for computer processing purposes, precision of distinction in accordance with geometric characteristics.

In order to provide additional information on manufacturing methods, the enterprise, together with VNIINMASh, has developed and implemented a Manufacturing Parts Classifier, correlated with the YeSKD Classifier. The design and manufacturing similarity of parts is determined by a set of characteristics, wherein the determining characteristic is a part's design.

The Manufacturing Classifier code alphabet is alphanumeric, the code length is 14 characters. The Manufacturing Classifier contains basic characteristics of

manufacturing classification (dimensional characteristic, group of materials, part's type according to manufacturing process) and characteristics of a part in relation to manufacturing process (casting, forging, swaging, cold stamping, machining, heat treating, forming of polymer and ceramic materials, coating, sintering, electro-physico-chemical treating).

Manufacturing processes listed in the Classifier are sufficient for classifying the entire population of parts at the eneterprise.

Based on using the YeSKD Classifier and the Manufacturing Classifier, an information retrieval system (IPS) for YeS computer is used at the enterprise, which made it possible to considerably reduce the time and expenditures for tooling up for production and performing predesign work on GPS creation.

To form the IPS data base, the following design and manufacturing characteristics of parts were used:

part number per MNSChKh;

description;

YeSKD code that determines geometric characteristics;

letter;

number of the product that includes the part;

overall dimensions of the part;

standard material consumption;

weight;

grade of material, standard on chemical composition, grade of replacement material;

labor standards;

type of blank, standard on rolled stock, dimensions;

dimensional precision;

surface roughness;

code per Manufacturing Parts Classifier;

manufacturing routing;

the number of the last engineering change order;

data on basic design elements of the part and on parameters thereof (threads, grooves, shoulders, slots etc.);

data on quality elements (types of heat treatment, coatings).

The body of data on parts drawings is created by recording on punch cards data from the drawing, the bill of material and the manufacturing process.

Parts data are set into and stored in a computer both in a coded form and in the form they are presented on drawings.

After the data base has been created, data are added to it on newly developed parts and information is being updated, based on engineering and manufacturing change notices, in order to maintain the truthfulness of the data base.

The further IPS development can go in three directions:

broadening the scope of problems to be solved and the range of objects;

improving hardware and providing service programs;

improving organizational support.

Broadening of the scope of problems is achieved by improving the data base organization and support: adding missing characteristics of existing objects (parts) and including new objects in the data base.

Hardware improvement and development of service programs mean facilitating users' access to information, reducing information retrieval time etc. In this respect, IPS operation in the dialog mode using alphanumeric displays is stipulated, as well as providing the capability to receive an image at the workstation.

Improvement of organizational principles of IPS functioning consists in releasing documents that insure cooperation of various departments.

Annual savings to the enterprise, due to implementation of the automated parts information processing system, reached 100 thousand R.

BIBLIOGRAPHY

1. Taller, S.L. and Razevskiy, S.I., "On Improving Manufacturing Parts Classifier", STANDARTY I KACHESTVO, 1983, No 9.

2. Movshovich, B.M., "Implementation of GOST 2.201-80 and YeSKD Classifier in Industries Using Non-"Personalized" Numbering System", STANDARTY I KACHESTVO, 1984, No 10.

3. Taller, S.L., "Basic Principles for Structuring YeSKD Classifier", STANDARTY I KACHESTVO, 1984, No 3.

4. Taller, S.L. and Tokareva, N.K., "Classification of Parts in YeSKD Classifier", STANDARTY I KACHESTVO, 1982, nO 6.

5. "Tekhnologicheskiy klassifikator detaley mashinostroyeniya i priborostroyeniya" [Manufacturing Classifier of Machine and Instrument Parts], Moscow, Izdatelstvo VNIINMASh, 1984.

6. "Metodicheskiye ukazaniya SAPR "Avtomatizirovannyy vybor ratsionalnykh form organizatsii mekhanoobrabatyvayushchego proizvodstva" [Procedural Instructions SAPR "Automated Selection of Rational Organizational Forms in Metalworking Industry"], Moscow, VNIINMASh, 1984.

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ON PROBLEM OF IMPLEMENTATION OF GOST 2.201-80 AND YeSKD CLASSIFIER

Moscow STANDARTY I KACHESTVO in Russian No 3, Mar 86 pp 39-41

[Article by E.Ye. Berezovskiy and V.T. Sidyuk, NIIPTMASh, under rubric "Suggestions and Remarks"]

[Text] In regards to the upcoming implementation of the YeSKD Classfier and GOST 2.201-80 "YeSKD. Designation of Products and Design Documents", the problem of the expediency of implementing these documents is being widely discussed in the press (and not only in professional publications at that).

In some publications, the YeSKD Classifier is subjected to sharp criticism and is being called an abstract document carrying no information. Some authors are voicing a concern that the GOST can become a hindrance in the work on broadening the usage of products, providing unification and specializing production thereof (e.g., see article in "Pravda" of 5 June 1985 "Does It Advance or Hinder?"). Apparently, such authors have not familiarized themselves well enough with the basic principles of the YeSKD Classifier structuring and the results of the complex practical testing thereof, which are far from confirming the opinions of those denying the Classifier usefulness.

In our opinion, the implementation of the YeSKD Classifier and GOST 2.201-80 will help expedite organization of manufacturing of new products by way of integrated automation of all phases of the manufacturing process, improve production preparation and scheduling based on type-design and specialization, will create wider opportunities for unification of parts and assemblies and insuring products' manufacturability, will free development personnel from performing routine, non-creative operations of receiving and changing design documentation (KD), will considerably improve the quality of KD and products that are being developed.

This conclusion is based on practical testing of the YeSKD Classifier and GOST 2.201-80, conducted by Kramatorsk Scientific-Research and Design-Technological Machine Building Institute (NIIPTMASh).

The testing objectives were to:

to check the comprehensiveness of coverage by the YeSKD Classifier of parts, assemblies, complexes and sets that are designed in NIIPTMASh;

determine the correctness of selection of classification parameters;

identify duplication in assigning product numbers;

assess the sufficiency of Classifier's capacity (registration numbers);

determine the necessity of additional symbols for designating versions of group documents;

identify inaccuracies in terminology.

The procedure for performing this job was specified in organizational documents, as well as in normative and procedural materials that were developed.

Drawings numbering was performed on copies of design documents of products developed earlier.

Design documentation of representative products of manufacturing equipment used in metallurgy, foundry, welding, metalworking, assembly and forging has been checked, 5,166 drawings all in all, which is about 40% of the annual volume of drawings produced by the Institute.

Practical testing covered nine classes of products and tooling that are starting points for further classification and that are also the most generalized groupings that provide products classification on the basis of belonging to a certain industry; the testing also covered one class of assemblies for general machine building application and six classes of machine and instrument parts.

Among the selected representative products, less than 8% of assemblies and 1% of parts turned out not to have been numbered, which indicates a high degree of the possibility of covering thereof by the YeSKD Classifier (we have not considered blanks, standardized and purchased components).

The results of numbering design documentation are presented in the table.

Of course, the YeSKD Classifier and GOST 2.201-80 are not without flaws. For instance, the testing determined that the comprehensiveness of products coverage by the Classifier is insufficient. Thus, in class 04, codes for "Means for Mechanization of Metal-Cutting Machine Tools", "Metering Devices", "Maintenance and Installation Kits" etc. were missing. In class 30, missing were types 305168 and 306344 "Stairwells with Landings" and "Hydraulic Cabinets". Also in this class, hopper tanks, ducts, trays, chutes, troughs for granular materials were missing. Therefore, subclass 307000 should be titled "Vessels and Tanks...".

In class 44, subassemblies of positioners were missing, such as cutter, gripper, frame, receiver etc.

In class 65, missing was a subgroup "Panels (with Instruments) with Maximum Overall Dimension up to 1,200 mm" with subsequent break-down into types, as in

existing subgroups.

Quantitative Results of Numbering Representative Products

(1) Наименование изделия (2)	(9) Количество составных частей в изделии		(12) Количество составных частей, обозначенных по Классификатору ЕСКД		(13) Количество составных частей, коды которых отсутствуют в Классификаторе ЕСКД	
	сборочных единиц (10)	деталей (11)	сборочных единиц (10)	деталей (11)	сборочных единиц (10)	деталей (11)
Установка импульсной формовки для опок 800×700 мм	366	1185	331	1180	35	5
(3) Машина полунепрерывной разливки заготовок	288	1293	271	1282	17	•11
(4) Агрегат газокислородной резки металлов больших толщин	162	1206	154	1206	8	—
(5) Магазин-накопитель	34	195	32	195	2	—
(6) Манипулятор ПУМ-250	37	276	,36	276	1	—
Приспособления станочные, сборочные, литейные, обработки давлением (7)	22	102	20	101	2	1
(8) Итого...	909	4257	844	4240	65	17

Key:

1. Product name
2. Pulse forming unit for 800 x 700 flusks
3. Machine for semi-continuous blank casting
4. Unit for gas-oxygen cutting of thick metal
5. Hopper-accumulator
6. Munipulator PUM-200
7. Fixtures (for machine tools, assembly, casting, pressure shaping)
8. Total
9. Number of components in the product
10. Subassemblies
11. Parts
12. Number of components designated in the YeSKD Classifier
13. Number of components for which codes in the YeSKD Classifier are missing

Besides, in class 65, there are no codes for multi-motor electrical drives with compound control, as well as codes for accessories and spare parts kits for the above products and for all the products in the class.

In class 70, subgroup 702740 "Equipment Installation" is missing, with "Electrical", "Hydraulic", "Pneumatic", "Lubricating", "Cooling", "Composite" equipment types.

As of today, there is no correlation in numbering design documentation in YeSKD and documentation prepared in accordance with other interindustrial systems. In our opinion, in order to eliminate this defect, this latter documentation should be referred to the basic product number with code "D" per GOST 2.102-68.

The assessment of correctness of selection of classification parameters has shown that in distributing products there are cases of violation of parameters selection.

For instance, in class 30, groups 3015-3017 "Fastening Elements, Stiffeners, Fasteners" are not base devices; subclasses in class 48 are picked according to different characteristics; there is no common characteristic in class 66 (group 6612); the functional use characteristic in subclass 661 is kept inconsistently; classifications of housing subassemblies in group 3011 and base members in class 73 are not correlated; in classes 71-76 "Parts", the L/D parameter has complicated preparation of group design documents.

In the process of practical testing of the YeSKD Classifier, cases of duplication, both within and between classes, were spotted.

For instance, there are "Panels" and "Bodies" in classes 30 and 61, "Cabins" in classes 48,61 and 66, "Electrical Equipment" for controlling machines in classes 45 and 66. This is because thee is no clear delineation of machine subassemblies in class 30 and specific subassemblies of functional classes in "Components" subclasses.

In "Parts" classes, the same product can be assigned different codes. For instance, a "Coupling Nut" is designated a "Fastening Nut", code 758423, and a "Union", code 753124; gasket type parts can have codes as a "Body of Revolution", code 711140, and a "Sealing Gasket", code 754150. "Clevis", "Lug", "Fork" type parts are located in different classes, which should be combined into one classification grouping.

When assessing the sufficiency of the YeSKD Classifier capacity, it has been found that in classes 71 and 74 "Parts" registration numbers capacity has been 50% used up, if "No drawing" (BCh) parts are taken into account. Therefore, it would be expedient to establish a four-digit registration number in the code structure, rather than a three-digit one. In order to rationally use the capacity of classes 71-76, "No drawing" parts should be assigned part numbers according to the rules for group documents. In this case, parts registration numbers can be permanent for parts of all types, whereas a dimensional characteristic registration can be accomplished using the version number.

In reviewing and analyzing products manufactured by batch or base methods, it has been found that an additional number of characters is needed for assigning registration numbers to product versions. This is due to a number of additional parameters that characterize a product and to possible combinations of elements thereof. Among such parameters are:

for parts that are not bodies of revolution: dimensional series of thicknesses (by roll stock range), length-to width ratio within a given thickness, location of design elements, manufacturing accuracy and surface roughness, material, coating;

for parts that are bodies of revolution type: dimensional series of outside diameters, L/D ratio within a diameter, dimensional series of inside diameters within an outside diameter, location of design elements,

manufacturing accuracy and surface roughness, material, coating.

As a result of testing the terminology used in the YeSKD Classifier, it has been found that occasionally terms are encountered that do not correlate with products names or have several versions. For instance, a part "Cylindrical Pin" can have the following names: "Pin", "Finger", "Axle", ""Stop", "Plug" etc; a part "Washer" can be named "Ring", "Shim" etc.

In class 30, the name of subclass "Vessels, Except Pressure Vessels" should apparently be changed to "Tanks, Except Pressure Tanks", because the Classifier contains tanks for transporting explosives, solutions etc. The term "Tanks" is more general than the term "Vessels" and covers all types of vessels.

The testing also showed the need to correlate GOST 2.201-80 and GOST 2.102-68, GOST 2.108-68, GOST 2.113-75, GOST 2.503-69, RD 50-171-79.

All these drawbacks were summarized, suggestions were prepared and sent to VNIINMASh and head developers of classes.

It is quite obvious that the work should be continued. The more organizations and enterprises implement the Classifier, the sooner it could be brought to the form that most comprehensively satisfies all industries.

In spite of some drawbacks that were found during the complex practical testing of GOST 2.201-80 and the YeSKD Classifier, the Institute started, as of 01.01.85, implementation thereof, together with a draft of the Manufacturing Machine and Instrument Parts Classifier. To this end:

a local design-manufacturing product classifier (KTK) was developed, based on the YeSKD Classifier and the draft of Manufacturing Machine and Instrument Parts Classifier (TKD); the KTK includes reference data on product designation structure, names of common characteristics of parts and code designations in the form of classification charts necessary for preparing a bill of material for computerized information processing;

STP 154-84 "System for Numbering of Products and Design Documents. Assignment, Registration and Storage Procedure" was implemented. The STP specifies basic provisions and a unified procedure for assigning numbers to products of main and auxiliary departments and to design documents;

all standard products covered by the enterprise standards were assigned numbers, and the numbers have been stored in a computer;

documents registration forms were purchased;

a schedule was developed for examination of technical documentation in order to identify the passive and the active design documentation fund in the archive:

design and manufacturing engineers responsible for documentation numbering and communication with the standardization department in solving day-to-day

problems were designated;

GOST 2.201-80, the YeSKD Classifier and other procedural and normative documents were studied in Engineering and Manufacturing Engineering departments and in the Documentation Support and Circulation department;

charts on numbering newly developed technical documentation and renumbering documentation released earlier, using the "non-personalized" system, were compiled.

As of now, over 20 thousand drawings of individual production products (non-standard equipment) have been numbered. A number includes the design-manufacturing code of a product (part, subassembly, complex, kit), consisting of a code of classification grouping of design characteristics (per the YeSKD Classifier) and a code of manufacturing characteristics (per TKD, restrictive part), which is enclosed in parentheses in the "Part Number" column of the bill of material. When the new number is entered into a document released earlier, the existing number is retained (a double number). In this case, on the basis of the engineering change notice, the new number is entered in the empty space in columns 2 and 26 (or above these columns) of the title block per GOST 2.104-68, and the old number is enclosed in parentheses.

In order to prevent duplication of drawing numbers, the latter are entered into a number registration card, and in order to perform the work on unification, a systematization card is created, where the part's sketch and basic parameters are presented.

In organizing the work on implementing the YeSKD Classifier, one should proceed from the fact that design documentation designation is an indispensable part of principal documents (the drawing and the bill of material) and that it must be performed by developers in the design department under procedural leadership by standardization departments.

It is not possible to present in this article all specificities and difficulties that have occured in the process of implementing the YeSKD Classifier. We would like to mention, however, that the YeSKD Classifier implementation is an important prerequisite for solving a lot of problems in an automated enterprise management system.

With the introduction of a "non-personalized" numbering system, the following functions are supposed to be automated, among others:

formation of the product contents base and keeping track of usage of parts and subassemblies in a product;

preparation of a preliminary, as well as the general and partial (by production departments) bills of material;

calculation of standard labor content and material standards for manufacturing a product;

preparation of the list of fixtures for manufacturing a product;

calculation of nomenclature production schedules for production departments and specialized bays.

The authors are far from the thought that the optimum ways have been found for solving all the problems that come up during the implementation of the YeSKD Classifier. However, we sincerely believe that the implementation thereof is necessary. It will create prerequisites for more efficient solutions of problems that come up in developing automated design systems (SAPR), automated control systems (ASU), including automated systems for the control of technological processes and production (ASUTP), and developing flexible manufacturing systems (GPS) and robotechnical complexes (RTK).

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ENTERPRISE STANDARDIZATION DEPARTMENT'S STANDPOINT ON IMPROVING STANDARDIZATION AND CERTIFICATION

Moscow STANDARTY I KACHESTVO in Russian No, 3, Mar 86 pp 44-45

[Article by V.V. Mizitskiy, manager, KTOS, Costroma "Tekstilmash" plant]

[Text] The importance of standardization in accelerating the technical progress and improving the quality of products is well known.

At the same time, however, it is impossible nowadays not to talk about the imperfection of individual facets of standardization. Thus, the job of enterprise standardization departments is considerably complicated by large volumes of newly developed and revised state and industry standards and instructional technical materials (RTM); in some cases, by not always justifiable and/or timely changes thereof; by the duplication of or, on the contrary, contradiction between individual requirements; by the complexity of coordination, approval and registration of technical standards documentation; by the imperfection of the state certification procedure.

The authority of a state standard is higher every year. Industry procedural standards are quite a different story. What new, specific for an industry, material can be contained in industry standards of "Organization of Products Manufacturing", "State Certification Procedure", "State Tests" etc. types? None at all! And it is no surprise that, as a rule, they just repeat all statements of corresponding state standards. The situation is even worse, when an industry standard somewhat, at first sight, insignificantly, deviates from the state standard requirements.

Deviations can take place, but they should be only exceptions dictated by the specificity of an industry, i.e. the development of such industry documents must be extremely limited.

Another type of industry standards, restrictive standards, repeat in an abridged form the nomenclature of state standards. If one adds to this the reduction in the number of standard sizes of standardized products that is specified by restrictive lists of enterprises, it is easy to come to a conclusion about useless work of a large group of professionals at industry institutes and enterprises on developing these standards, the work that is reduced to unnecessary scribbling. Also unjustifiable are mandatory implementation of a number of industry standards and especially RTM and the development of organizational and technical measures with subsequent accountability to a Ministry and its industry institutes. The uselessness of

a number of industry standards (when state standards are available) is also corroborated by the indifferent attitude towards them on the part of inspecting organizations: people's control, Minvneshtorg, LGN and even Gosstandart that approved these NTD(!?).

In our opinion, the time has come, firstly, to reduce the number of organizational and procedural NTD, and secondly, to replace restrictive standards by simple restrictive usage lists.

Tremendous organizational confusion, alienation of design engineers from their direct responsibilities, and, in some cases, direct financial losses are caused by unjustified and inopportune implementation of new state standards and changes therein. It suffices to quote the following example. GOST 10304-80 "Rivets. General Technical Specifications", introduced as of 01.01.81, provided for the replacement of a digital designation by a letter one. The design documentation had been corrected, but a year later change No. 1 went back to the old, digital designation. And again wasted work.

The story with GOST 13941-68 "Flat Spring Thrust Rings and Grooves Therefor. Dimensions" was even worse. Effective 1983, a new standard, approved in 1980, was supposed to be introduced. But the new ring design, according to specialists' findings, was strength-wise inferior to the old one. In 1983, the duration of the old standard was extended until 01.01.85. Beginning in January, 1985, departments of our enterprise and the special design bureau for textile machinery (Costroma SKBTM) have started changing the documentation and reworking the tooling: there was no other way, as the new state standard had become effective, and, in addition, inspectors could have dropped in any minute. But in March, before all the work had been completed, Information index No. 5 reported that the new standard had been revoked and that the duration of the old one had been extended until 01.01.86 (?!). Imagine how much time and money had been wasted just by our plant, let alone specialized enterprises that manufacture these rings.

The still existing trend to cover by standardization as many objects and activity areas as possible practically leads to the development of such standards as "Personnel Selection and Training", "Rules for Conducting Ten-Day Meetings", "Procedure for Handing In and Drawing Up Rationalization Proposals".

Such and similar standards of all ranks with far-fetched requirements stifle manager's initiative, his independence and scope of activities.

There is no question that the number of standards should be smaller, but they should be of a better quality and, as a rule, apply to finished products.

The Procedure for state certification of products also calls for further improvement. The requirement of mandatory demonstration of products, that have applied for the state Quality Symbol, at VDNKh can hardly be met and, as a rule, is not observed.

More stringent requirements to products of the highest quality category should be but greeted, because there still are a lot of cases, when the honorary

pentagon decorates low-quality products. The "Better less, but better" motto could not be more appropriate. And the most important thing here is competitiveness, the superiority, and not just mere being in line with the best world analogs.

Base quality indeces should incorporate all achievements of the world science, rather than stay at the level of indeces of newly mastered products. In this case, it would be sufficient to compare a sample of a product only to these prospective, the world's highest, standards; the need would disappear for comparison with domestic and foreign analogs, as well as would disappear the need for labor consuming calculations of generalizing ratios that determine nothing. Standards with stepped prospective quality indeces, that are being developed by various industries, solve precisely this problem, but the new form of the level card does not take this into account: as before, one should specify both domestic and foreign analogs and introduce the same generalizing ratios. And, of course, the prospective indeces must not be at the level of today's achievements, but significantly higher, because long cycles of development and then starting production in two to three years will, by the time the series production will have started, again throw us back, into secondary positions. For instance, it is no secret that even now new developments of certain machines, still at the prototype stage, do not match up to the level of series machinery manufactured by leading foreign companies. Does it, for instance, make sense to prepare and rearrange production facilities for manufacturing in 1987 of the so called "new" worsted spinning machine, if this machine is far from the modern level and has been in the development stage since 1981?

Under such circumstances it will be extremely difficult to accelerate the scientific and technical progress. In this, the general customer's is not the least important role. In the above example, the general customer is the USSR Ministry of Light Industry, whose position in developing new equipment is, mildly put, inconsistent.

The effectiveness of certification is lowered by unsatisfatory organization in certain industries of the collection of information on the current level of foreign analogs. Thus, the base institute of Minlegpishchemash, VNIILTekmash, does not take a principal stand on these issues and, depending on the situation, now confirms the absence of foreign analogs, now finds them. With such an approach to the acceleration of technical progress on the part of the industry's leading institute, not only will not the plants have any products that could be certified in the highest category, but there will be nothing for them to manufacture at all.

For instance, a pneumatic-mechanic machine PPM-240-Sh1, 17.5 m long, weight 11 tons, with a sophisticated electrical diagram, a unique spinning device and thousands of parts, the machine that is covered by 12 author's certificates and patents and is in the category of especially sophisticated products, has not been certified in the highest quality category, only because a more productive analog emerged in ChSSR.

The new state certification procedure has not yet become a reliable shield from certifying secondary products. Amazing is the fact of certification in

the highest quality category of such consumer goods as, for instance, ax-cutter and garden kit. In the first case, it is a wooden handle with slightly polished and sharpened metal part, in the second - a planting fork and two planting scoops. Isn't it a discreditation of the very essence of certification? May we ask, which guidelines were the GAK [state certification commission] and registration agencies following in certifying the above "masterpieces"?

The time has come to assign all simple products to products that do not need certification.

Certification plays a positive role in encouraging and improving the quality of products. Still, the important thing is not the honorary pentagon, but product's quality itself.

It makes sense not to assign the highest category to a product that has been manufactured for over four to five years (allowing for one to two years for mastering production and three years for subsequent certification). This will, on one hand, organize and facilitate the entire certification system, and on the other, will induce the developer and the plant to modernize or renew manufactured products.

Additional difficulties are created by inoperativeness in providing enterprises with necessary technical standards documentation.

Here are the freshest examples: Riga standards bookstore mailed out GOST 380-71 "General Purpose Carbon Steel. Grades and Technical Requirements" without incorporating change No. 3. A local TsNTI [Center for scientific and technical information] has the standard edition with change No. 3, but under the title "General Purpose Carbon Steel". In the last Standards Index GOST 15612-78 "Products Made of Wood and Wood Materials. Methods for Determination of Surface Roughness Parameters" is effective until 01.01.86, whereas in the GOST 15612-78 itself the duration is stated until 01.01.85.

The list of such examples can go on and on.

In order to improve the activities of QC departments in the area of incoming inspection of materials and components, suppliers must be obliged to include TU with a shipment of materials and components.

The flow of NTD and, even more, of documents relating to YeSKD, YeSTD, ORD, KS UKP, YeSTPP, SSBT (a system for PO (PP) control is coming), falls mainly upon the shoulders of small, not yet strong and authoritative enough standardization departments. The situation is further complicated by the fact that some business executives have a very vague idea of standardization, its objectives, sphere of influence, responsibilities of standardization personnel etc.

In light of the need to accelerate the scientific and technical progress, the role and authority of standardization departments must grow. They should be permanently given assistance; the sphere of education of engineering and technical personnel, including business executives, should be broadened, as

should be broadened the training of specialized personnel.

Sore subjects of improving and, at the same time, simplifying the state standardization system are our common cause.

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ALL-UNION MEETING ON STANDARDIZATION IN DOMESTIC SERVICES INDUSTRY

Moscow STANDARTY I KACHESTVO in Russian No 3, Mar 86, pp 74-75

[Article by V.V. Kuritsyna, VNIIS]

[Text] On November 25-27, 1985, in pavilion "USSR Standards" at VDNKh, based on the exhibition "60 Years of USSR Standardization", a meeting of domestic services industry professionals took place.

Among the participants were chiefs and deputy chiefs of technical departments and heads of standardization departments of Ministries of Domestic Services of Union Republics, leading professionals of design institutes and domestic services industry enterprises, designers from a number of republican Houses of Models.

The following problems were reviewed:

the status of standardization of the domestic services industry in Union Republics;

information on the realization of the "Program for Expansion and Improvement of Standardization of Domestic Services industry in 1982-1986";

prospects for expansion of standardization in the domestic services industry for the period of 1986-1990 and until the year 2000.

A report "Ways for Improving Standardization in Domestic Services Industry" was made by V.I. Potemin (VNIIS). It was noted that, in the light of the Integrated program for expanding the production of consumers' goods and the servise industry, adopted in September, 1985, problems of great social importance have been brought to the attention of service industry personnel, and personnel of domestic services industry in particular: maximum satisfaction of needs and improving the quality of services. The speaker emphasized the idea that, for solving the problems, along with other existing management methods, it is necessary to form and use a management mechanism based on standardization, that insures improvement of publis production efficiency, labor productivity, technical level and quality of products and services.

The report covered the status of standardization in the domestic services industry and pinpointed the main problems of standardization development that

have to be solved in the near future.

V.V. Kuritsyna (VNIIS) reported on the status of realization of the "Program for Expansion and Improvement of Standardization of Domestic Services industry in 1982-1986" and on the development of a program for 1986-1990, as well as on the problems of scientific-procedural and organizational character in this area. She talked about the development and implementation of an NTD [technical standards documentation] complex that had been completed in 1983-1985 within the framework of the realization of the program; mentioned procedural and organizational difficulties caused by the absence in the country of the head standardization organization and by inadequate coverage of legal problems of standardization in the domestic services industry.

V.I. Smirnov (VNO.IIS) made a presentation on the activities of the state inspection of standards in the domestic services industry. At present, only domestic services of an industrial character are the objects of state inspection in the domestic services industry.

To ascertain the conformance of the service provided to the requirements of standards and technical specifications, state inspectors that supervise standards and measuring instruments check products ready for release to a customer or for sale. This has to be confirmed by an appropriate signature or a stamp on an accompanying document.

According to inspection results (as of the first quarter of 1986), NTD violations were found at 20 domestic services enterprises, out of 48 enterprises. The basic reasons for violations were:

poor organization or lack of quality control of services;

lack of measuring instruments at domestic services enterprises;

lack of technical documentation at the enterprises;

violations of technological discipline.

Problems of establishing warranty periods in standards and technical specifications for products repaired or manufactured per individual orders were covered in a report by E.S. Erenburg (VNIIS).

On the second day, reports on the basic directions for the development of standardization in the domestic services industry in Union Republics were made by: L.E. Ross (PTI, Minbyt, Estonian SSR), L.P. Kantorovich (KTB [design and technological bureau], Minbyt, Kirgiz SSR), G.S. Bakinovskaya (NPO [scientific industrial association] "Belbyttekhnika"), L.A. Sedko (UkrNIKTIbyt), I.M. Savchenko (Minbyt, Moldavian SSR), L.Ya. Andrutsis (LatGiprobyt) et al.

Professionals of republican Ministries of Domestic Services analyzed the available NTD stock, delineated basic directions for work on standardization and raised a number of questions related to defining standardization objects, certification of products, lack of coordination between state and industry

standards on consumers' goods and products for improving living conditions, on one hand, and the NTD that is in force in the domestic services industry networks in Union Republics, on the other.

The participants voiced a strong concern in regards to the procedure for approval of standards for domestic services, because of the absence of an organization representing the main customer.

In adopted recommendations, the meeting participants agrred that it was necessary:

1. To carry out standardization in the domestic services industry as to: forming an optimum NTD stock and improving the scientific and technical level thereof; the development of state and industry standards for basic types of services; increasing the socio-econimic importance of standardization; improving the data base organization and support in the industry.

2. Ministries of Domestic Services of Union Republics must insure unconditional meeting of the program's targets, including the implementation of the NTD complex.

3. To meet the requirements of the Integrated program for expanding the production of consumers' goods and the service industry, Ministries of Domestic Services of Union Republics must take an active part in the development and realization of the "Program for Expansion and Improvement of Standardization of Domestic Services industry in 1982-1986", by including corresponding assignments in NIR [scientific research work] plans of subordinate institutes.

4. Ask Gosstandart to examine the problem of excluding from the list of products subject to certification production equipment manufactured within the system of Ministries of Domestic Services of Union Republics for using within the industry.

5. Ask Gosstandart to assign an organization representing the main consumer of services in the process of approving standards for domestic services.

6. Head and base organizations must insure the improvement of the scientific and technical level of technical standards documentation developed, taking into account the trend towards customers' satisfaction and improving the quality and culture of services.

7. In planning and performing standardization, take into account tne need to use the achievements of the scientific and technical progress in all areas of national economy.

8. In order to improve coordination of and procedural leadership in standardization in the domestic services industry, create a corresponding section of Gosstandart NTS [scientific and technical counsil].

9. Solve the problem of providing Ministries of Domestic Services of Union Republics with industry standards developed within the framework of the above program.

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ON IMROVING QUALITY OF STANDARDIZING RELIABILITY FACTORS IN TECHNICAL STANDARDS DOCUMENTATION

Moscow STANDARTY I KACHESTVO in Russian No 3, Mar 86 pp 42-44

[Article by Candidates of technical sciences A.V. Yapin and V.I. Tetykhin, Interindustrial Skill Imrovement Institute for professionals in Latvian SSR national economy]

[Text] With the increase in the technical level and the quality of industrial products, it is only natural that the requirements to reliability thereof become more stringent; for the quantitative assessment of reliability, group reliability factors (GPN) are used.

Using GPN for the assessment of industrial equipment quality, preparation of repair and maintenance schedules thereof, calculation of repair facilities, necessary machine fleet and spare parts therefor, as well as for other technical and economic calculations, has demonstrated its value in practice. However, these characteristics are of little value when assessing a limited number of products (or a single product) [1].

Taking into consideration the more stringent requirements to quality of products, Gosstandart approved GOST 27.003-83 "Equipment Reliability. Selection and Standardization of Reliability Factors. General Data" (introduction date 07.01.85) that regulates not only group, but also individual standards of reliability factors (PN) in technical standards documentation (NTD). Those individual standards characterize the reliability of a single product of a given type (make, model) and are called specified reliability factors (UPN): specified reliable life, specified useful life (life, time of keeping quality), that are particular cases of gamma-percentage parameters at =100%.

So far, there are no clear recommendations on standardizing PN; this process calls for improvement [1, 2] that, in our opinion, should be directed at the improvement of the scientific and technical level and the quality of NTD at all levels, namely:

including in standards, technical requirements (TU) and operational documentation (ED) PN nomencalature that reflects as completely as possible the required reliability features, in accordance with specific applications and conditions of product application;

correct PN presentation in sections of NTD;

using precise and unambiguous scientific and technical terms and definitions.

The mandatory character of specifying PN in NTD, their nomenclature, rules for selection, standardization and presentation, as well as terms and definitions, are specified in GOST 1.5-68, GOST 2.114-70, GOST 21623-76, GOST 22851-77, GOST 27.002-83 and GOST 27003-83. However, analysis of NTD at all levels made it possible to determine that in some documents there are significant flaws that impede the solution of a number of problems and significantly lower the NTD quality.

For instance, in GOST 16998-81E "Vacuum Machinery. Technical Requirements", GOST 21346-82E "Horizontal Mixers. Technical Requirements" etc., only the longevity factor (PD) is regulated: in the first GOST this is the specified original life, in the second- specified operating service life, whereas GPN are not specified.

By the same token, in GOST 2914-80 "Electrical Reversible Single-Barrel Winches. Technical Requirements", GOST 16215-80 "General Use Fork-Lift Trucks. General Technical Requirements", GOST 24123-80 "Truck Mounted Hydraulic Jib Cranes. General Technical Requirements" etc., as well as in a large number of ED for industrial products, instead of a complex of PN, only the longevity factor is specified, namely, mean or -percentage life, even though it is known that it is impossible to objectively assess the reliability of machines only by life or operating service life. Apparently, standards for such products should include, besides PD, also maintainability and other parameters.

Some standards (GOST 23928-79E "Lines for Packaging of Preserved Food Products in Metal and Glass Cans. General Technical Requirements", GOST 25365-82 "Steam and Hot-Water Boilers. General Technical Requirements", GOST 25783-83 "Hydrodynamic Torque Converters for Construction and Road-Building Machinery. General Technical Requirements", GOST 22718-77 " Compact Tractor for Transporting Carts with Containers and Packages. Technical Requirements" etc.) not a single PN is included at all, whereas GOST 27.002-83 contains a unique statement: "Reliability is a complex feature that, depending on object's use and conditions of application, consists of a combination of failure-free performance, longevity, maintainability and keeping quality".

Regulating in NTD only one parameter that characterizes a feature of reliability (let alone the absence of PN in some standards and TU) contradicts the requirements of GOST 22851-77 "Selection of Nomenclature of Quality Parameters of Industrial Products. General Data", GOST 27.003-83 and procedural instructions RD 50-149-79-M [3], and does not allow to objectively assess the technical level and quality of products, neither does it allow to perform certain practical engineering and economic calculations.

In recent years, gamma-percentage values (life, service life, time of keeping quality, time to first failure) have been ever more specified as standard GPN in NTD, which, according to data in [4], is caused by lower duration of check tests. In our opinion, it makes more sense to assess all properties,

characterized by GPN, basically by mean values, and to use gamma-percentages (except for certain types of products) as additional parameters.

Comparing to gamma-percentages, mean values are simpler and enjoy broader practical application. For instance, if there are no data on mean life, and the standard gamma-percentage life is available, in performing technical and economic calculations one still has to "convert" the second into the first, by specifying the coefficient of variation and the distribution law [5]. Besides, mean values have higher accuracy than the gamma-percentage ones. According to data in [6], with the coefficient of variation v=0.3-0.6 and the most widely used distribution laws (normal, log-normal and Weighbull's laws), mean lives have close results, whereas gamma-percentages can, in the case of different distribution laws, differ by several fold.

Hence, in the case of recalculating the standard gamma-percentage life into mean life, the results also can differ.

The expediency of using mean values instead of gamma-percentage ones is also mentioned in [7].

PN should be properly incorporated into appropriate sections of NTD, otherwise PN are confused with equipment storage and operation warranty periods; unfortunately, this is facilitated by inaccuracies in YeSKD standards (GOST 2.601-68, GOST 2.607-72 and OST 22-10-75), as well as in GOST 4.93-83E "System of Product Quality Parameters. Machine Tools. Nomenclature of Parameters".

Following these standards, the majority of manufacturing plants repeat these inaccuracies in products' ED, making even bigger mistakes. For instance, in technical certificates (logbooks) of scraper DZ-87-1 manufactured by "Dormash" plant (Berdyansk), of T-130 tractor and its modifications manufactured by Chelyabinsk tractor plant etc., the "Warranty" (GO) section, besides the warranty period and the service life during this period, unjustifiably includes "80% service life to first overhaul...", i.e. gamma-percentage life.

Such phrases bring confusion to concepts "warranty" and "guaranteed" and are conducive to erroneous interpretation thereof, even though the differences between them are covered in great detail in [8] and in GOST 22352-77 "Manufacturer's Warranties. Specifying and Calculating Warranty Periods in Standards and Specifications. General Data".

In addition to PN, some manufacturers also include in the GO section of ED parameters of failure-free performance, for instance, probability of survival [9].

Unjustifiable incorporation of GPN in the GO section of various levels NTD causes arguments between manufacturers and customers, sometimes even forcing them to resort to the help of mediating commissions [9].

GPN are most important components of technical characteristics of machines and, in accordance with the requirements of GOST 22352-77, they must be incorporated in the "Technical Requirements" section of standards and TU.
Unlike GPN, guaranteed service lives and guaranteed lives are not only

technical, but also legal concepts, and the manufacturer has a financial responsibility, according to current legislation, for violations thereof; in accordance with requirements of GOST 22352-77, these parameters must be included in the "Manufacturer's Warranties" section of NTD.

To a certain extent, the quality of NTD depends on precise and unambiguous scientific and technical terminology specified in GOST 27.002-83. However, this obvious rule is not always observed. Thus, in paragraph 2.17 of GOST 20572-83E "Double-Screw Pumps and Units. Technical Requirements", the following parameters are specified: "mean life...", "specified life...", "specified service life...", but without mentioning the final condition at which the life and service life are standardized: whether it is an overhaul or a write-off.

Similar inaccuracies are also present in GOST 20883-83E "Triple-Screw Pumps and Units. Technical Requirements", in GOST 25662-83 "Vacuum Equipment. Vacuum Diffusion Pumps. Basic Parameters. Technical Requirements. Test Methods" and in a number of ED.

In our opinion, it makes no sense to specify in NTD such terms as "80%, 90%" and so on life (service life, time of keeping quality), instead of standardized gamma-percentage life (service life, time of keeping quality) at, for instance, =80% or at other probabilistic values, as it happens in some standards, in particular, in GOST 4.52-79 "System of Products Quality Parameters. Piston Internal Combustion Engines. Nomenclature of Reliability Parameters", in GOST 10150-82 "Marine, Locomotive and Industrial Diesel Engines. General Technical Requirements" etc., in which a term "ninety-percent time of keeping quality" is used.

Usage of non-standardized terms and concepts in NTD impedes understanding thereof. Thus, technical certificates of hydraulic machines (type 223 axial-piston pumps, manufacturing date 1981), manufactured by Moscow machine building plant imeni M.I. Kalinin, state: "Life to first overhaul not less than 4,000 hours". The same life for the same type pumps was specified the same year by Odessa "Stroygidravlika" plant, but there a footnote to technical certificates reads: "Not less than 90% of all hydraulic machines must meet this requirement..." How is one supposed to understand this?!

According to the requirements of GOST 27.002-83, products service life is determined by the calendar duration of operation (year, month), whereas operating life is determined by life in hours, cycles, kilometers etc. However, in some standards, for instance, in GOST 14774-81E "Filling Machines for Food Liquids. Types and Basic Parameters. General Technical Requirements", GOST 15087-81E "Capping Machines for Glass Bottles with Food Liquids. Types and Basic Parameters. General Technical Requirements", GOST 24740-81E "Lines for Packaging Liquid Products in Glass Bottles. Types and Basic Parameters. General Techical Requirements" etc., the "specified service life to first overhaul" is determined in hours, whereas in GOST 5618-81E "Electrical Generators (Hydrogeneators). General Technical Requirements" the "specified operating life..."is given in years. Such presentation leads to confusion of terms "operating life" and "service life" and lowers the NTD quality.

A number of standards (GOST 15880-83 "Electric Drills. General Technical Requirements", GOST 19713-81E "Asychronous Three-Phase Squirrel-Cage Motors up to 0.75 kW Capacity for Sewing Machines Drives. General Technical Requirements", GOST 20548 "Cast Iron Sectionalized Heating Hot Water Boilers up to 85 kW Capacity. General Technical Requirements", GOST 25223-82 "Woodworking Equipment. General Technical Requirements" etc.) and ED, instead of "Reliability Factors" present "Reliability and Longevity Factors", i.e. reliability and longevity are presented as equivalent concepts, even though they are different level factors.

The inadmissibility of such inaccuracies in scientific and technical publications was pointed out in [10], and in State standards and other NTD they should not take place all the more.

Based on the above, one can, in our opinion, give the following recommendations:

in practice it is necessary to widely use group (mass) PN for the assessment of machine products quality and in various technical and economis calculations. UPN that are standardized in NTD facilitate the assessment of a single product quality;

for a more comprehensive technical characteristic of machine products, NTD at all levels must specify (taking into account product's group and type) a PN complex that includes GPN (longevity, failure-free performance, maintainability and keeping quality) and UPN;

it is suggested, at the time of republication of existing standards, TU and ED that include only one PN or one UPN, to incorporate in them the necessary PN nomenclature, in accordance with the requirements of GOST 22851-77, GOST 27.003-83 and procedural instructions [3];

mean values (mean time to first failure, mean time between failures, mean service life, mean time of keeping quality) should be specified as basic GPN in NTD, whereas gamma-percentage values (with the exception of certain types of products) should be used as supplemental parameters;

GPN should be included in the "Technical Requirements" section of Standards and TU, and in those cases when there is no such section, in the "Basic Technical Data and Characteristics" section;

eliminate the practice of using in NTD of all levels of non-standardized terms, concepts and expressions that are not given in GOST 27.002-83.

BIBLIOGRAPHY

1. Kubarev, A.I., Aronov, I.Z. and Burdasov, Ye.I., "Normalization of Reliability Factors in Technical Standards Documentation", STANDARTY I KACHESTVO, 1984, No 4.
2. "Results of Discussion on Problems of Normalization of Reliability in Technical Standards Documentation", STANDARTY I KACHESTVO, 1983, No 12.

3. RD 50-149-79-M. "Metodicheskiye ukazaniya po otsenke tekhnicheskogo urovnya i kachestva promyshlennoy produktsii" [Procedural Instructions on Assessment of Technical Level and Quality of Industrial Products], Moscow, Izdatelstvo standartov, 1979.

4. "Metodicheskiye ukazaniya po otsenke, prognozirovaniyu i normirovaniyu resursa i bezotkaznosti selskokhozyaystvennoy tekhniki" [Procedural Instructions on Assessment, Forecasting and Normalization of Service Life and Failure-Free Operation of Agricultural Equipment], Moscow, "Mashinostroyeniye", 1981.

5. Kozlovskaya, M.P., "Improve Reliability of Construction Machines", MEKHANIZATSIYA STROITELSTVA, 1980, No 5.

6. Kugel, R.V., "Nadyozhnost mashin massovogo proizvodstva" [Reliability of Mass Production Machinery], Moscow, "Mashinostroyeniye", 1981.

7. Dzirkal, E.V., "Zadaniye i proverka trebovaniy k nadyozhnosti slozhnykh izdeliy" [Specifying and Checking Reliability Requirements for Complex Products], Moscow, "Radio i svyaz", 1981.

8. Shor, Ya.B. and Kugel., R.V., "Products Reliability Factors and Assessment Thereof", in book "Kachestvo, nadyozhnost i dolgovechnost produktsii" [Qality, Reliability and Longevity of Products], A.I. Antonovskiy and K.M. Kryshkin, editors, Moscow, Izdatelstvo standartov, 1966.

9. Volkov, B.N. and Veprinskaya, L.I., "Some Legal Problems of Regulating Reliability Factors in NTD", STANDARTY I KACHESTVO, 1983, No 11.

10. Borisov, I.K., "On Problem of Reliability Terminology", NADYOZHNOST I KONTROL KACHESTVA, 1980, No 11.

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EXPANDING THE CAPABILITIES OF A STANDARD REMOTE INFORMATION SYSTEM TIS-2E

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[Article by engineers B. D. Shoykhet and N. P. Novichkov of the Voronezh Power Authority Voronezhenergo, under the rubric "Improvements in the Operation of Electric Power Grids": "Expanding the Capabilities of a Standard Remote Information System TIS-2E"]

[Text] In 1984 the Kalacheyev Electricity Network Enterprise [PES] of the Voronezhenergo Voronezh Power Authority put into operation an automated system of dispatcher control [ASDU] of PES based on a standard equipment complex TIS-2E comprised of an Elektronika-60 microcomputer, an alphanumeric printer, two color displays IPGP (one for controller-computer dialogue and the other--an event display--for the output of messages about switches and operating condition disruptions) and an interface device linking the system with remote-control equipment [USTM].

Due to the simplicity of system-user communication, a convenient format of current information display and effective signalization of events, an improvement in performance quality and reliability is achieved by the operations control service, the production sections and the administration-management units.

The introduced system discharges the following functions:

- input and processing of remote data from the substations of RES [rayon electricity networks]. At the present time, 104 remote measurements [RM] and 370 remote signals [RS] from 18 substations of four rayons of PES are fed into the system and processed. In the nearest future, the volume of remote data will be increased to 187 RM and 760 RS, respectively, and the number of remote-control substations will be increased to 32;

- the output onto the dialogue display screen of current time and date of event. As the source of time marks, a stabilized generator is used, installed in the microcomputer instead of a standard timer. The time marking error is about 10 s per 24 hr, which is quite acceptable. In addition, the possibility for time and date correction by the controller is provided;

- monitoring of incoming remote data. When the readings pass beyond the specification limits, the positions of switch gears are changed, and also in case of an activation of relay protection, an information message is fed onto the event display, giving a detailed description and exact time of the

event. These data are entered into the event file for a daily printout in the form of a systematic report of disconnections and operating condition violations. A capability is provided for blocking unreliable RM and RS from the display keyboard. The event display operates in a waiting mode; the screen is turned on when an information message appears. Simultaneously, a sound signal is produced to attract the controller's attention;

- the output, onto the dialogue display screen, of measurement lists from the substations. For attracting the controller's attention, the readings that pass beyond the specification limits are indicated on the screen in blinking red lights. Every 10 s the current data are updated;

- output onto the dialogue display screen of lists indicating the positions of switch gear and the emergency signals of relay protection. The list is updated automatically when any of the listed signals changes its state. When an emergency signal of relay protection (ground, overheating, gas protection, etc.) is fed, the corresponding letters appear in red blinking lights (for normal operation a steady green light is used);

- the output onto dialogue display screen of 32 color mimic flowsheets of the substations. On a mimic flowsheet, the symbols of the switches are represented by colors indicating the switch position (on or off). When the position of an object is changed, its symbol changes color. A possibility of manual input of graphic or alphanumeric data into the mimic flowsheet of any substation is provided, including the registration of the input information in the working memory;

- the output onto the dialogue display screen of the tables of specification limits of readings for each substation. The controller can modify any of the specification limits, after which the measurement monitoring is done in compliance with the new limits;

- output onto the dialogue display of blocked-out RM and RS;

- output onto the printer of tables of current remote measurement data for all the substations. The format of the table is similar to that of RM lists on the display screen. The output is done during "peak" hours (9, 10 and 11 p.m.) routinely or at any time on demand from the controller;

- output onto the printer of systematically organized daily reports of switch-off and operating condition failures separately for the substations. The output is done routinely at 8 p.m. or at any time on the controller's demand. It should be noted that the alphanumeric printer is activated automatically before the data output; and

- the retention of the data file in the working memory in case of a power supply failure for a period of up to 4 min. This time is sufficient for switching over to a redundancy supply source--a diesel electric generator with a programmed control (activation time 40-45 s). The circuit of intermediate redunancy power supply of the computer provides the supply to the circuit boards of a voltage +5 and +12 V (the peripheral devices are disconnected for the time of activation of the diesel generator).

One of the features of the Kalacheyev Electric Power Network ASDU is the ramified two-level system of remote data collection and transmission. The first level (substations--rayon controller station of RES) is realized on remote-control devices Kust-B and channel-forming ASK-RS equipment with APT-100; it operates in four rayons of electric networks, including 18 substations of 110, 35 and 10 kV with an information capacity of 119 remote-control signals [RC], 370 RS and 104 RM.

The second level (RES--the operating-information complex of PES) is comprised of remote-control devices TM-512, which retransmit data (104 RM and 370 RS) from four remote-controlled rayons, with input into the microcomputer for subsequent processing.

For the further development of ASDU of PES, it is necessary to install remote-control equipment at the substations in the remaining three rayons of electric networks and to pass over in 1986 to a three-computer complex (SM-1420 minicomputer and two SM-1800 microcomputers). This complex will be sufficient for handling current information and also performing electrical engineering calculations and economic-management calculations.

There are plans to bring into operation an intercomputer information exchange between the operating-information complex of PES and operating-information complex of rayon power authorities of Voronezhenergo, which will be using TELEES complex. The software of the existing system has been developed by in-house efforts at Voronezhenergo. The software package of TIS-2E was taken for the base. The installation, adjustment and maintenance of the complex is provided by the personnel of the local service of the system of dispatcher-technological management of PES.

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THE CONSTRUCTION AND USE OF LOGICAL FEATURES IN A PRODUCTION MANAGEMENT AUTOMATION SYSTEM OF HEAT AND POWER PLANT

Moscow ENERGETIK in Russian No 4, Apr 86 pp 21-22

[Article by A. A. Aleksanov, engineer, and V. I. Shcherbich, candidate of technical sciences, Mosenergo Moscow Power Authority Computer Center — Belorussian Energy Scientific Research Institute imeni G. M. Krzhizhanovskiy, under the rubric "Automated Management Systems and Computer Technology": "The Construction and Use of Logical Features in a Production Management Automation System of Heat and Power Plant"]

[Text] In developing a production automated management system [ASUTP] for a heat and power plant, an important function is a computer evaluation of technical-economic indicators [TEI] of power units and the plant as a whole in real time (for a 15-minute period, a shift, a 24-hour period and a month). It is essential to monitor correctly and on time the heat flows from the power units and the directions of these flows, which may change in connection with the duty-schedule switches or because of emergency situations.

An up-to-date automated system monitors the direction of heat flows by using so-called logical features [LF] which define the state of the equipment and the fittings in a discrete form (LF = 1: equipment operational; LF = 0: equipment idle). As the heat fluxes increase, the importance of LF and correct determination of its state grows.

The important LF of the heat supply power units cover the following operation conditions:

- condensational or heat-supply according to the heat-supply or power-supply duty schedule;
- operation of network heaters [PSG];
- high-pressure heaters [PVD]; and
- peak-load water-heating boiler, etc.

For example, the total number of LF at the power unit T-250-240 used to determine the TEI alone is greater than 60. According to the standard algorithm for TEI calculation, the logical features should be determined by the signals from discrete sensors. For testing the signals and providing the necessary reliability of LF, each of the sensors feeds two

signals into the computer (open, closed or on, off); this involves the use of a substantial cable capacity. In order to reduce the cost of data collection, it is desirable to decrease the requisite number of discrete signals.

This can be attained by using the measurements of analog parameters performed for other functions of ASUTP. The analysis of the input data entered into the computer for the calculation of TEI and for other functions indicates that analog parameters when used to form an LF series carry redundant amounts of information.

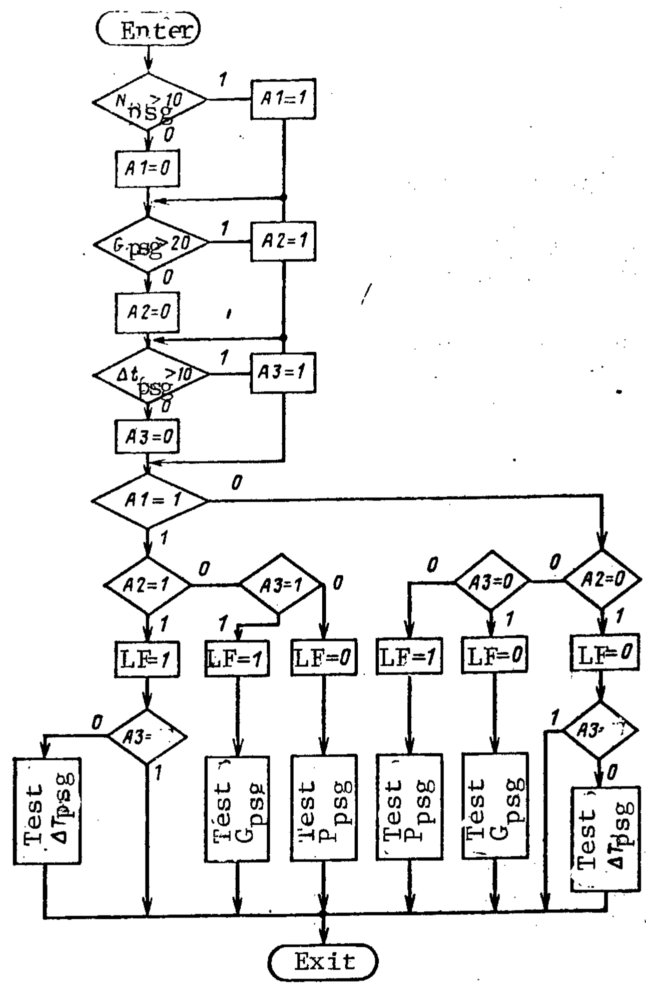

Figure 1. Structural flowchart of the algorithm of combined parameter reliability control and determination of LF of PSG operation.

The availability of redundant information can be used to ensure the acceptable reliability of LF. In addition, it offers an opportunity for combined verification of the signals of analog and discrete sensors used to determine

the LF. There are principles for combined determination of LF from analog parameters and reliability control of data, which have been realized in ASUTP of heat of power and supply plant No 21 of Mosenergo.

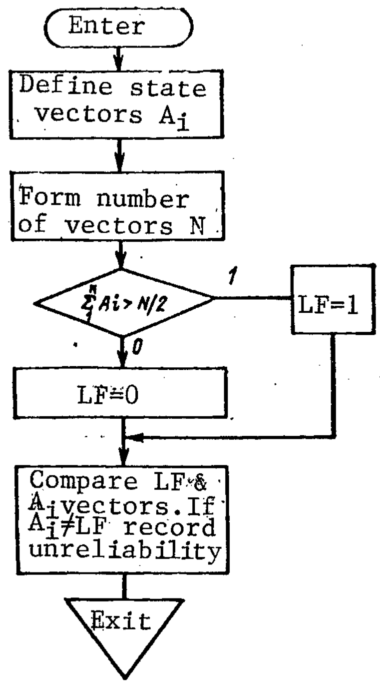

Figure 2. Structural flowchart of the generalized algorithm of the combined parameter reliability control and determination of the LF of the operation of the equipment of power units.

In constructing an LF, the analog information is converted by using cutoff values into a discrete function Ai. If the value of $Ai = 1$, the equipment is operating; otherwise, $Ai = 0$. The more information units are used to define an LF, the greater number of discrete functions Ai will confirm the LF of an equipment state.

The logical features are defined by a majority testing. For example, if there are three functions Ai ($A1$, $A2$ and $A3$) LF is constructed according to the "two-out-of-three" method. With this principle, it is possible to define LF reliably and, in addition, to verify the data: the value of the parameters used to construct the vector of state, which is at variance with the value of the logical feature, is invalidated.

It is well known that during around-the-clock industrial operation of the instrument fleet of an ASUTP it is fairly difficult to discern the "zero drift" of the sensor, which introduces a gradually increasing error into the TEI calculations. The sensor error may be positive (overrated readings) or negative (underrated readings).

When a value of LF changes from 1 to 0, one can apply combined logical control of data reliability to detect a "zero drift" of flow meters and mechanism-power measurement units, reduce their readings to a zero and generate a computerized message about the failure that has arisen, so as to take measures to eliminate it. As a result, the values of TEI, defined by the parameters being monitored, become much more reliable.

We will consider examples of the construction of LF with combined control of parameter reliability. Figure 1 shows an algorithm for constructing LF of a PSG operation based on three measured analog parameters: the power of condensate pumps P_{PSG}, the condensate flow rate G_{PSG} and water heating in PSG $\Delta T = T''_{PSG} - T'_{PSG}$. The functions of state Ai are expressed as follows: $A1 = 1$ for $P_{PSG} > 10$ kW, $A2 = 1$ for $G_{PSG} > 20$ t/hr, $A3 =$ for $\Delta T_{PSG} > 5°C$. Combining the reliability control with the construction of LF makes it possible to verify and reject parameters.

The algorithms for determination of a series of LF can also be constructed using a larger number of discrete functions Ai and of the parameters measured, respectively. For example, for forming LF describing the operation of a PVD group, seven vectors are used:

$A1 = 1$, if the steam valve of PVD 8 is open;
$A2 = 1$, if the valve of PVD 7 is open;
$A3 = 1$, if the valve of PVD 6 is open;
$A4 = 1$, if the water heating in PVD 8 > 10°C;
$A5 = 1$, if water heating in PVD 7 > 10°C;
$A6 = 1$, if water heating in PVD 6 > 10°C; and
$A7 = 1$, if water heating in the group of PVD > 20°C.

Figure 2 gives the flowchart of the generalized algorithm of LF definition with the combined verification of parameter reliability when forming N discrete functions Ai.

The operation experience of heat and power supply plant No 21 has shown that this method is capable of providing an acceptable reliability of LF, raising the efficacy of automated control of the reliability of parameters measured and saving the cable capacity.

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AUTOMATING CALCULATIONS OF ESTIMATES AND REPORT DOCUMENTS ON EQUIPMENT REPAIR

Moscow ENERGETIK in Russian No 4, Apr 86 p 23

[Article by S. S. Gerzon, engineer, Nizhnetagil Electric Network, under the rubric "Automated Management Systems and Computer Technology": "Automating Calculations of Estimates and Report Documents on Equipment Repair"]

[Text] In planning-economic work of electric network enterprises [PES], substantial amounts of labor go into making estimates for repair and overhaul of equipment and electric power networks and preparing documents reporting the completed work, as well as reports on costs of the overhaul for each unit of basic stock inventory.

The planning and preparation of documents on overhaul repair work is the responsibility of foremen, documentation technicians and planning-economic services of the enterprise. It is quite frequent that just the typing of hundreds of manually calculated estimate sheets covering an annual amount of work costs about 1 million rubles and continues for months.

By structure, the estimates for overhaul repair are different from estimates prepared for the construction of new substations and electric power networks so that the design organizations which have computer technology do not accept orders for preparing the estimate documentation on overhaul repairs.

Among the functions of management automation system in power equipment repairs (in particular, using the software of the Belorussian Energy Scientific Research Institute imeni G. M. Krzhizhanovskiy), which has been in use at PES for several years, is the calculation of estimates on a computer of unified ES series. The estimates, however, are prepared only for the types of work included in the maintenance repair schedule. In practice, the estimates have to be prepared throughout the year and in certain cases covering the work already completed, such as in the case of emergencies or operations performed to prevent failures.

In view of the above, the planning and economic analysis functions for management automation system of PES have been expanded to include the calculations of estimates on minicomputers provided for PES.

At the Nizhniy Tagil Electric Networks of Sverdlovenergo Power Authority, a software package has been developed for calculating the estimates and preparing the reports on repairs of all kinds of equipment and power lines, in accordance with the normative documents currently in effect. In developing the software, efforts were undertaken to reduce as far as possible and simplify the volumes of input data used for calculating the estimates and reports in accordance with Form 2 and OC-3 (for completed repair work) and subsequent use of report and estimate data for economic analysis.

All input data are written in a blank form, listing requisite data items describing the equipment or power lines being repaired and enumerating the codes (indices) of the unit cost estimates and amounts of work involved. The employees preparing the input data refer to the existing normative quotas and do not have to do any calculations. For statements of completed work, similar forms with a different title are prepared.

The information support component includes the operation unit codes, a guide to inventory objects and the normative data base specifying the unit costs for all types of repair work on equipment and power and communication lines. The guide to inventory objects lists coefficients for including the transportation costs in case of the objects being situated at a distance (over 30 km) from the repair base. A procedure for computing this coefficient has been developed.

The normative base lists the unit costs for standard operating conditions specifying the following resources: the total cost of a work item, wages, material costs, operation costs of mechanisms, transportation costs, labor. and wire and lumber return. The efficiency of wire and lumber return in performing repair work is determined according to the condition of the materials, the feasibility of transporting them, etc.

For estimating the totals of the resources for an object, a structural unit or the whole of PES, the coefficients of seasonal cost adjustment and costs of extraordinary items are included. When a form of the document reporting a complete work according to Form 2 is processed on a computer, the average annual cost increase of operation is specified according to the month when the work is done by using the coefficients given in the normative documents for the particular months. All the documents are presented in compliance with the format established.

The program offers a capability of economic analysis of reporting and estimate information:

- comparing the volumes and nomenclature of work actually completed (Form 2) with work items as planned in estimates and defined in completed work forms (Form OS-3);

- monthly current reports on work completed; and

- cost itemization by categories.

The use of the computer simplifies the processing of planning and economic analysis documentation, relieves the foremen of clerical and calculation work, reduces the amount of work performed by the staff of the planning and economic analysis department, improves the accuracy of calculations and ensures faster repair information processing.

The software is written in memory code PVK M-5000 and can be run on all program-compatible computers, including the SM-1600 computer, manufactured currently by the industry.

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PROGRAM PACKAGE FOR CONSTRUCTING ANALYTICAL MODELS OF INDUSTRIAL ROBOTS

Moscow MASHINOVEDENIYE in Russian No 2 Mar-Apr 86 (manuscript received 20 Sep 85) pp 26-30

[Article by M. Vukobratovich and N. Kirchanskiy (Belgrade, Yugoslavia)]

[Text] Complex multidimensional nonlinear dynamic systems are controlled with the use of control computers differing in their complexity, from large ones at the level of the modeling of the dynamics of the system and synthesis of the control algorithm to microcomputers directly controlling the system. One of the main decisive problems in controlling an industrial robot is the generation of a dynamic on-line model. For this purpose, a separate microcomputer or several computers operating in the multiprocessor mode are used.

The existing methods of robot dynamics simulation which are based on the equations of Newton-Euler, Lagrange and others [1-3] require a large number of numerical operations and they cannot be realized in real time: the time spent on the construction of a model is several times greater than that acceptable for the computer. This is explained by the following factors: complexity of the mathematical model, the use of a high-level language for programming, the desire to construct an algorithm of a general kind, which leads to high redundancy of numerical operations; the use of recursion relations, which excludes the possibility of performing parallel operations during the realization in a computer.

Special characteristics of the construction of a program system which is to a considerable degree free of the above drawbacks is considered below. Instead of directly constructing a model in the numerical form on the basis of one of the approaches of classical mechanics, the concept of constructing a model in symbols is proposed here. It is possible to show [4, 5], that in this way it is possible to obtain a compact mathematical model which requires fewer numerical operations (multiplication, addition) for its realization by two orders in comparison with the methods used earlier.

A linearized model in symbols [6] and (or) the same model of sensitivity is formed in the other modules of the program. The first one of them is used further when applying the linear theory of automatic regulation [7, 8], an the second is used for evaluating the reliability and the synthesis of adaptive control. An algorithm for obtaining a model in symbols optimized with respect to the number of numerical operations is realized in a special module. A special "graph" is obtained at the output of this module which determines the optimal sequence of

the performance of operations during the construction of a dynamic model. Then the program is automatically translated into a low-level language ("Assembler") or a high-level language (ALGOL, FORTRAN and others).

The program compiled in this way is entered in a microcomputer. This work gives an example illustrating the on-line obtaining of a program code for two modern computers.

Main Modules of the Program Package. Input-Output Module. This module is used for communication of the computer with the user in the interactive mode. The user must give the following initial data: the number of the degrees of mobility of the robot mechanism; its geometrical and dynamical parameters; parameters and orientation of the external load. The following information is obtained at the output of the module: signals about errors if the initial data are entered incorrectly, graphic representation of the kinematic circuit of the robot, a dynamic model proper in the form of dynamic equations of the robot's mechanism. The following can be obtained in the interactive mode: graphic representation of any desired analytical expression, its simplification, simplification of the model with graphic representation, selection of the type of the model (nonlinear dynamic model, linearized model or model of sensitivity), selection of the programming language for representation of the output code of the model.

Module for Obtaining an Analytical Model of the Robot. This module is one of the main modules in the program package and is intended for generating an analytical model of an arbitrary open kinematic circuit.

Mechanical systems simulated by open kinematic circuits are described by systems of nonlinear dynamic equations which can be represented in the following matrix form:

$$P=H(q,\ \theta)\ddot{q}+\dot{q}^{T}C(q,\ \theta)\dot{q}+g(q,\ \theta), \tag{1}$$

where P -- vector with a dimensionality of n motive forces or moments; q=q(t) -- n-dimensional vector of linkage coordinates; H(q, Θ) -- inertia matrix with a dimensionality of nXn; C(q, Θ) -- matrix of centrifugal and Coriolis forces with a dimensionality of nXn, g(q, Θ) -- n-dimensional vector of gravitational forces; Θ -- vector of parameters; n -- number of the degrees of mobility of the robot's mechanism.

By using any of the known methods of setting up dynamic equations and constructing a model of an industrial robot, expressions for the matrices contained in (1) can be obtained in a closed form [5, 6]. Due to the complexity of conversions, only the final result is given here:

$$H_{ik}=\sum_{j=\max(i,k)}^{n}\Big[m_j\rho_{ji}\rho_{jk}+\sum_{\mu=1}^{s}\eta_{j\mu}{}^{i}\eta_{j\mu}{}^{k}J_{j\mu}\bar{\xi}_i\bar{\xi}_k\Big],$$

$$\begin{aligned}C_{k,l}^{\,i}\underset{(k>l)}{=}\sum_{j=\max(i,k)}^{n}\Big\{m_j\rho_{ji}(e_l\times\rho_{jk})+\frac{1}{2}\sum_{\mu=1}^{s}\big[\eta_{j\mu}{}^{i}\varepsilon_{lk}+\eta_{j\mu}{}^{k}\varepsilon_{il}+\\ +\eta_{j\mu}{}^{l}\varepsilon_{ik}\big]q_{j\mu}J_{j\mu}\bar{\xi}_k\Big\}\bar{\xi}_l,\quad g_i=-\sum_{j=1}^{n}m_j\rho_{ji}G,\end{aligned} \tag{2}$$

where e_i -- unit vector of the axis of the i-th linkage; $\rho_{ij}=(e_j \times r_{ij})\bar{\xi}_j+e_j\xi_j$; r_{ij} -- vector of the center of mass of the i-th section in relation to the center of the j-th linkage; $\xi_j = 0$, if the j-th pair is a rotational pair and $\xi_j = 1$, if the j-th kinematic pair is a progressive pair; $\bar{\xi}_j=1-\xi_j$; $\eta_{j\mu}{}^i=e_i q_{j\mu}$, $q_{j\mu}$ -- unit vector of the μ-th coordinate in the system rigidly connected with the i-th link; $\varepsilon_{ij} = e_i X e_j$; m -- mass of the i-th link, J_{i1}, J_{i2}, J_{i3} -- moments of inertia in relation to the major axes of the i-th link; G -- vector of acceleration created by gravitational forces.

The nonnumerical approach to system simulation consists in determining the functional dependence of any of the variables (for example, e_i, r_{ij}, etc) contained in the equation (2) on the linkage coordinates at the prescribed vector of parameters. This means that the variables are considered as functions of the linkage coordinates, and the parameters -- as numerical constants. This approach will be termed the numerical-symbolic (or analytic) approach to the construction of a model. As is shown in [3], the linkage-lever mechanism is characterized by the variables $a_j \in R^l$, $j \in N = (1,\ldots,n)$, l is equal to one for the scalar variable and to 3 for the vector variable which can be determined by the relation

$$a_j=\sum_k a_{jk}(\cos q_1)^{c_1}\ldots(\cos q_n)^{c_n}(\sin q_1)^{s_1}\ldots(\sin q_n)^{s_n}q_1^{k_1}\ldots q_n^{k_n}, \tag{3}$$

q_i, $i \in N$ -- i-th component of the vector of coordinates q, the exponents c_i, s_i, $k_i \in (0, 1, 2)$ depend on k, i.e., $c_i=c_i(k)$, $s_i=s_i(k)$, $k_i=k_i(k)$, $a_{jk}\in R^l$, $k\in K$, where K -- set of indexes $\{1,\ldots K_m\}$, k_m relates to observed variables a_j. Evidently, the variables of the system a_j can be represented in the form of the vector $A_j=[a_{j1}\ldots a_{jk_m}]^T\in R^{k_m \times l}$ and a matrix of the exponent

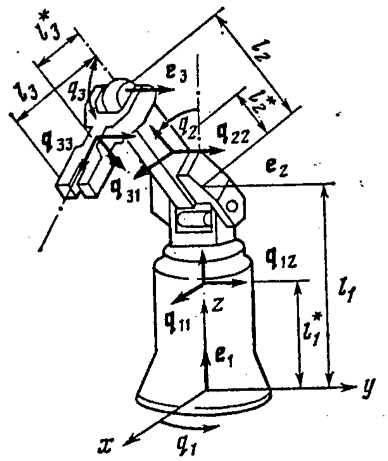
$$E_j=\begin{bmatrix} c_1(1)\ldots c_n(1) & s_1(1)\ldots s_n(1) & k_1(1)\ldots k_n(1) \\ \vdots \quad\quad \vdots & \vdots \quad\quad \vdots & \vdots \quad\quad \vdots \\ c_1(k_m)\ldots c_n(k_m) & s_1(k_m)\ldots s_n(k_m) & k_1(k_m)\ldots k_n(k_m) \end{bmatrix}, \tag{4}$$

having a demensionality of $k_m X 3n$. Thus, the variable a_j can be described by the ordered set (A_j, E_j). This set will be denoted by the symbol A and called "structural matrix" of a_j. On the other hand, the sum (3) represented by the structural matrix A can be considered as a polynomial

$$a_j=\sum_k a_{jk}x_1^{k_1}\ldots x_{3n}^{k_{3n}}, \tag{5}$$

where $x_i=\cos q_i$, $x_{n+i}=\sin q_i$, $x_{2n+i}=q_i$, $i\in N$. The variables $x_j = x_j(t)$ are connected with one another by the trigonometric relation $x_i^2+x^2_{n+i}=1$. The polynomial (5) is convenient for the examination of algebraic relations appearing during the simulation of a dynamic system.

If we analyze the expressions for the terms of the matrices (2), we can see that in order to obtain a structural matrix it is necessary to perform the following algebraic operations: multiplication of A·B, multiplication of AXB, addition of A+B and multiplication by the argument of the polynomial x_iA. Using expressions of the kind of (5), it is easy to perform such operations on a computer. For example, the product of $a_j X b_j$ assumes the form of



$$A_j \times B_j =$$
$$= \sum_K \sum_M (a_{jk} \times b_{jm}) x_1^{k_1+m_1} \ldots x_{3n}^{k_{3n}+m_{3n}} \tag{6}$$
$$(A_j, E_{A_j}) \times (B_j, E_{B_j}) =$$
$$= (A_j \times B_j,\ E_{A_j} + E_{B_j}).$$

The expression (6) has a high potential redundancy due to the interrelation of the variables x_i and x_{n+1}, $i \in N$. Taking into consideration that $x_i{}^2 + x^2{}_{n+i} = 1$, it is possible to simplify expression (5). The simplification procedure is systematically performed in the computer according to the incorporated program after any algebraic operation. By using the relations (2)-(4) recorded in a closed form, it is possible to obtain structural matrices for all members of the dynamic model H(q, Θ), C(q, Θ) and g(q, Θ) with the prescribed set of parameters Θ. For this robot, the obtained structural matrices are, evidently, constant. The computation of the numerical values of the elements of the model matrices is now simple due to the equivalence of the structural matrices and the polynomials (5). The problem becomes more serious if we set the problem of minimizing the number of multiplication and addition/subtraction operations required during the computations of the polynomials (5). This means the formulation of the problem of optimal factorization of a polynomial with many variables.

Program Module for the Optimization of Computation and Generation of a Model at the Output. The problem of the optimization of the computations of polynomials can be reduced to the analysis of the distribution of the exponents in the appropriate structural matrices. At any step of optimization, it is necessary to determine the exponent which occurs most frequently in the maximum number of the series of the matrix of exponents. Then, it is necessary to perform the factorization of the polynomial and memory input of the sequence of operations (multiplication and addition/subtraction). With the use of the obtained sequence of operations, this program module generates a set of instructions in a desired programming language which realize the computations of the dynamic equations of the industrial robot being studied. This output operated in the natural time.

Example. Let us examine an anthropomorphous industrial robot with three degrees of mobility shown in the figure (local systems of coordinates coincide with xyz at $q_1 = q_2 = q_3 = 0$). Three orthogonal systems of coordinates (q_{i1}, q_{i2}, q_{i3}) connected with the centers of mass of the links are used. The figure shows also the unit vectors e_i of the axes of the linkages. The parameters of the robot are recorded in Table 1.

$$\rho_{31}=\begin{bmatrix}0\\1\\0\end{bmatrix}x_1x_5+\begin{bmatrix}-1\\0\\0\end{bmatrix}x_4x_5+\begin{bmatrix}0\\0,2\\0\end{bmatrix}(x_1x_3x_5+x_1x_2x_6)+$$

$$+\begin{bmatrix}-0,2\\0\\0\end{bmatrix}(x_2x_4x_5+x_2x_4x_6).$$

Finally, in accordance with the equations (2), we obtain an expression for the elements of the matrices of the dynamic model (1). For example, for (H_{11},$E_{H_{11}}$), we have

$$H_{11}=\begin{bmatrix}4,57\\112,98\\26,80\\26,80\\2,68\\5,36\\2,68\end{bmatrix},\quad E_{H_{11}}=\begin{bmatrix}0&0&0&0&0&0&0&0&0\\0&0&0&0&2&0&0&0&0\\0&0&1&0&2&0&0&0&0\\0&1&0&0&1&1&0&0&0\\0&0&2&0&2&0&0&0&0\\0&1&1&0&1&1&0&0&0\\0&2&0&0&0&2&0&0&0\end{bmatrix}.$$

which corresponds to a polynomial of the kind of (5) $H_{11}=4{,}57+112{,}98x_5^2+26{,}8x_3x_5^2+$ $+26{,}8x_2x_5x_6+2{,}68x_3^2x_5^2+5{,}36x_2x_3x_5x_6+2{,}68x_2^2x_6^2$.

After the optimization of the number of the multiplication operations, we obtain an equivalent polynomial $H_{11}=4{,}57+x_5(x_5(x_3(2{,}68x_3+26{,}8)+112{,}98)+$ $+x_6x_2(5{,}36x_3+26{,}8))+2{,}68x_6^2x_2^2$, which contains 45% fewer multiplication operations.

At the output of the third program module, we obtain an optimal sequence of computations which in the FORTRAN language has the form of

$P3=X2*0{,}26800E+01$, $P2=X3*0{,}53600E+01$, $P1=X3*0{,}26800E+01$, $Q3=$ $=X2*P3$, $Q2=X2*(P2+0{,}26800E+02)$, $Q1=X3*(P1+0{,}26800E+02)$, $P3=$ $=X6*Q3$, $P2=X6*Q2$, $P1=X5*(Q1+0{,}11298E+03)$, $Q2=X6*P3$, $Q1=X5*$ $*(P1+P2)$, $H(1,1)=Q1+Q2+0{,}45700E+01$, where $X2=x_2=\cos q_2$, $X3=x_3=$ $=\cos q_3$, $X5=x_5=\sin q_2$, $X6=x_6=\sin q_3$.

Let us note, that the program given here is only a small part of what is available at the output and must ensure the computation of all terms of the matrices of the dynamic model according to (1), (2). The number of multiplication operations n_{mul} and additions/subtraction n_{add} can be determined by simply counting the elements of the output of the module. Table 2 shows the number of operations and the computation time in application to an anthropomorphous industrial robot, where L -- sine and cosine computation with the aid of a program library, C -- computation of the same values with the aid of tables with linear interpolation. It also gives the data on the counting time of the matrices of the dynamid model

Table 1

i	m_i	J_{i1}	J_{i2}	J_{i3}
1	–	–	–	4,57
2	152	–	21,74	–
3	67	–	1,22	–

Table 2

cos/sin	n_{mul}	n_{add}	(1) Способы вычисления sin и cos	t, мс (2)		
				PDP 11/70	PDP 11/03	INTEL 86/87
4	49	23	L	1,1	54	6,3
			C	0,5	11	4,5

Key: 1. sin and cos computation methods
2. t, ms

Let us cite some intermediate results obtained during the construction of the matrix of the dynamic model.

The following structural matrices were obtained for the unit vectors of the axes of the linkages e_1, e_2 and e_3.

$$e_1=([0\ 0\ 1],\ [0\ 0\ 0\quad 0\ 0\ 0\quad 0\ 0\ 0],$$

$$e_2=\left(\begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \end{bmatrix},\ \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}\right),\quad e_3=e_2.$$

The connection between the structural matrix and the analytical expression of a vector, for instance e_2, has the form of

$$e_2=\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}\cos q_1+\begin{bmatrix} -1 \\ 0 \\ 0 \end{bmatrix}\sin q_1 \quad \text{or} \quad e_2=\begin{bmatrix} -\sin q_1 \\ \cos q_1 \\ 0 \end{bmatrix}$$

Structural matrices of the vectors ρ_{ij} are obtained with the use of the symbol processing technique described above. For example, for the vector $\rho_{31}=e_1 X r_{31}$, we have

$$\rho_{31}=\left(\begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0,2 & 0 \\ -0,2 & 0 & 0 \\ 0 & 0,2 & 0 \\ -0,2 & 0 & 0 \end{bmatrix},\ \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}\right).$$

This expression can be represented in the form of the polynomial (5)

on a minicomputer and on a 16-digit microcomputer. It can be said that the results turned out to be very encouraging for real-time use.

Bibliography

1. Uicker, J. J. "Dynamic Force Analysis of Spatial Linkages", ASME J. OF APPLIED MECHANICS, 1967, June, pp 418-424.

2. Hollerbach, J. M. "A Recursive Formulation of Lagrangian Manipulator Dynamics", IEEE TRANS ON SMC, 1980, Vol 10, No 11, pp 730-736.

3. Vukobratovic, M., Potkonjak, V. "Dynamics of Manipulation Robots", SPRINGER-VERLAG, 1982.

4. Vukobratovic, M., Kircanski, N. "A Method for Computer-Aided Construction of Analytical Models of Robotic Manipulators", FIRST IEEE CONF ON ROBOTICS, Atlanta, 1984.

5. Vukobratovic, M., Kircanski, N. "Computer Assisted Generation of Robot Dynamic Models in Analytical Form", ACTA APPLICANDEA MATHEMATICA, INTERNATIONAL J OF APPLYING MATHEMATICS AND MATHEMATICAL APPLICATIONS, 1984, Vol 2, No 2.

6. Vukobratovic, M., Kircanski, N. "Computer-Oriented Method for Linearization of Dynamic Models of Active Spatial Mechanisms", J MECHANISMS AND MACHINE THEORY, 1981, Vol 16, No 2.

7. Vukobratovic, M., Kircanski, N. "Decoupled Control of Robots Via Asymptotic Regulators", IEEE TRANS ON AUTOMATIC CONTROL, 1983, Vol AC-28, No 10.

8. Popov, Ye. P.,Vereshchagin, A. F., Zenkevich, S. L. "Manipulyatsionnyye roboty: dinamika i algoritmy" [Manipulation Operations: Dynamics and Algorithms], Moscow, Nauka, 1978.

9. Timofeyev, A. A., Yekalo, Yu. B. "Stability and Stabilization of Programmed Movement of Robots", AiT, 1976, No 10.

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